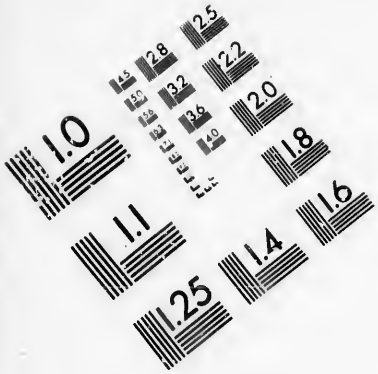

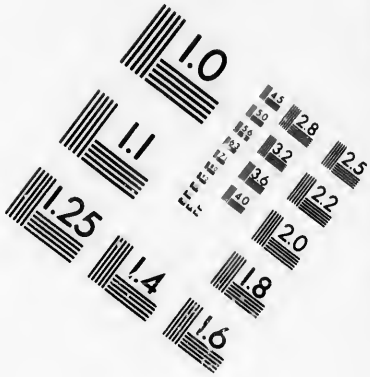

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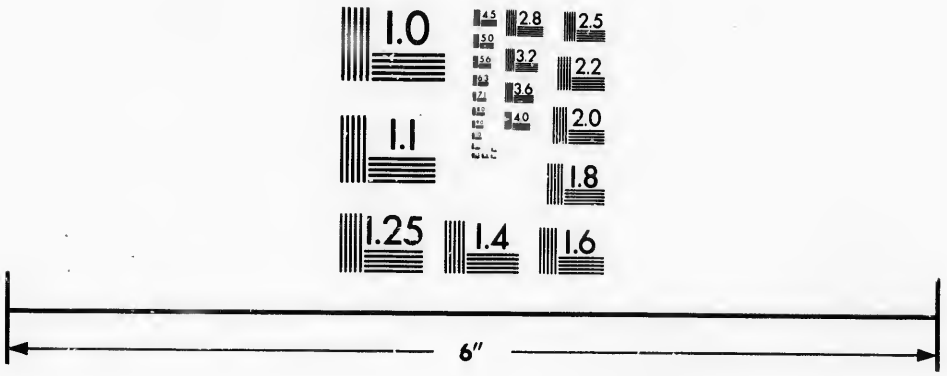

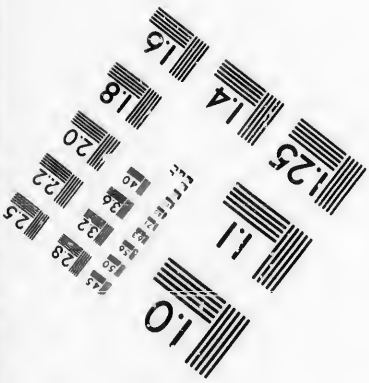

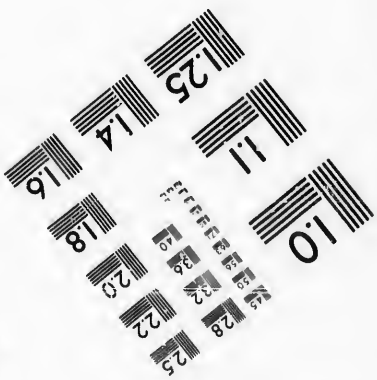

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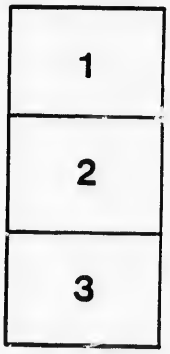

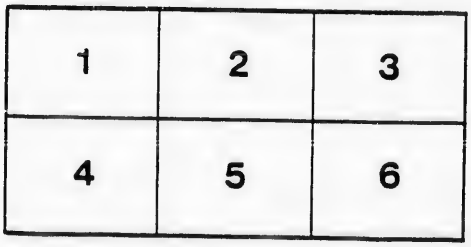

30 X

UNIVERSAL OR COSMIC TIME,

BY

SANDFORD FLEMING, C.E., C.M.G., ETC.

TOGETHER WITH

OTHER PAPERS, COMMUNICATIONS AND REPORTS

IN THE POSSESSION OF

THE CANADIAN INSTITUTE

RESPECTING

THE MOVEMENT FOR REFORMING

THE TIME-SYSTEM OF THE WORLD,

AND ESTABLISHING

A PRIME MERIDIAN

AS A ZERO COMMON TO ALL NATIONS

PUBLISHED BY THE

COUNCIL OF THE CANADIAN INSTITUTE.

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1885.

COSMIC TIME.

CONTENTS.

INTRODUCTION.

The documents included in this *fasciculus* not being part of the ordinary transactions of the Canadian Institute, their publication by the Institute calls for a word of explanation.

During the winter session of 1878–1879 Mr. Sandford Fleming, one of the earliest members of the Institute, communicated to the Society two remarkable papers—one on "Time-Reckoning," and the other on "The Selection of a Prime Meridian to be Common to all Nations, in Connection with Time-Reckoning."

These communications were of such world-wide interest, the questions discussed were of such practical importance, that the Council of the Institute thought it desirable that they should be brought officially under the notice of as many leading learned societies as possible, both on this continent and in Europe; this seemed all the more desirable inasmuch as the suggestions made by Mr. Fleming could only be carried out by the united action of the civilized nations of the world, and such action could be best secured through the intervention of the national scientific societies.

The Council accordingly addressed a memorial to the then Governor-General, the Marquis of Lorne, requesting him to transmit Mr. Fleming's communications to the Imperial Government and to the representative learned societies of Europe and America. His Excellency kindly acceded to their request, and in forwarding the papers to these scientific societies, he invited them to communicate to him their views upon the proposals discussed in the papers. The replies received have been placed by His Excellency at the disposal of the Institute, and are included in this volume.

In publishing these replies, and the other documents which accompany them, the Institute is influenced by the desire to preserve a full and permanent record of the history of this interesting scientific movement, from its first practical discussion before the Canadian Institute in the winter of 1878, until the virtual

adoption of Mr. Fleming's views by the International Scientific Conference at Washington in 1884.

In a paper read during the last winter before the Canadian Institute and included in this *fasciculus*, Mr. Fleming has given an interesting history of the whole movement, he has pointed out the share which many learned societies in Europe and America have taken in the work. He has honourably mentioned the names of many scientific men who have assisted in the discussion, nor has he forgotten to notice in what way the Institute has helped forward the movement. To his own continued earnest and honourable labours in the cause Mr. Fleming has made no reference. This omission the Institute is constrained to notice in justice to Mr. Fleming and in justice to themselves. They may say what he has left unsaid, that his efforts have contributed in no small degree to the adoption of an initial Meridian common to all nations, and that he has unquestionably been the initiator and principal agent in the movement for reform in Time-Reckoning and in the establishment of the Universal day. The Institute cannot, perhaps, better express the debt of gratitude which the civilized world owes to Mr. Sandford Fleming in this connexion than by quoting from the accompanying paper from the pen of the distinguished Astronomer Royal of Russia, M. Otto Struve: "It is," he writes, "through Mr. Fleming's indefatigable personal labours and writings that influential individuals and Scientific Societies and Institutes in America and Europe have been won over to the cause."

It is gratifying to the Institute to be able to put forward so honourable and independent a testimony to the value of Mr. Fleming's labours in this scientific revolution, and it is also to them a source of satisfaction to reflect that Mr. Fleming's views were first communicated to the Institute, of which he is one of the earliest and most honoured members, and further, that through their printed transactions, those views were brought prominently under the notice of the scientific world.

UNIVERSAL OR COSMIC TIME.

Read before the Canadian Institute, 20th December, 1884,

BY MR. SANDFORD FLEMING, C.M.G.

On the first day of the month the President of the United States, in his message at the opening of Congress, referred to the International Meridian Conference lately convened in Washington, in the following words :—"The conference concluded its labours on the first of November, having with substantial unanimity agreed upon the meridian of Greenwich as the starting point whence longitude is to be computed through one hundred and eighty degrees eastward and westward, and upon the adoption for all purposes for which it may be found convenient of a Universal Day, which shall begin at midnight on the initial meridian, and whose hours shall be counted from zero up to twenty-four."

The Canadian Institute is peculiarly interested in this announcement. No society, literary or scientific, has taken a more important part in the initiation of the movement to reform our Time-system, of which the success is, to some extent, indicated in the President's words. It therefore appears to me fit and proper that I should recall to your attention the various steps which from time to time have been taken, so that we may possess a record of the events which have led to the now almost general recognition of the necessity for a new notation.

Six years ago on several occasions the meetings of the Institute were engaged in discussing the subject of Time-reckoning and the selection of a Prime Meridian common to all nations. Papers were read and arguments were advanced, with the view of showing the necessity of establishing a cosmopolitan or universal time, by which the events of history might be more accurately recorded, and which would respond to the more precise demands of science, and generally satisfy the requirements of modern civilization. The proceedings of the Institute for January and February, 1879, give at considerable length the views submitted and the suggestions offered to meet the

new conditions of life. While on the one hand it was argued that the introduction of a comprehensive scheme by which time could be universally reckoned was highly desirable, it was equally maintained that the determination of a common Prime Meridian for the world was the key to its success, and that the establishment of such a meridian, as a zero, recognized by all nations, was the first important step demanded.

These proceedings were brought under the notice of His Excellency the Marquis of Lorne, then Governor-General of Canada. In the name of the Institute, they were submitted, in the form of a memorial,* with the hope that His Excellency would see fit to lay them before the Imperial Government, that they would by these means obtain the attention of the several scientific bodies throughout Europe, and that some general systematic effort would be made in the right direction to secure the important objects sought to be attained.

Through the good offices of His Excellency, copies of the Canadian Institute Proceedings found their way to the British Admiralty, the Astronomer Royal, Greenwich, The Astronomer Royal for Scotland, Edinburgh, The Royal Society, The Royal Geographical Society, The Royal Astronomical Society, The Royal United Service Institute, and other societies of eminence and weight in the United Kingdom. Copies of the papers were likewise sent through the Imperial Government to the Governments of the following countries, viz.:

FRANCE,	GERMANY,
ITALY,	NORWAY AND SWEDEN,
THE UNITED STATES,	RUSSIA,
AUSTRIA,	BELGIUM,
BRAZIL,	DENMARK,
JAPAN,	THE NETHERLANDS,
SPAIN,	PORTUGAL,
SWITZERLAND,	TURKEY,
GREECE,	CHINA.

In the year following, the American Metrological Society issued a Report of the Committee on Standard Time. The Report bears the name of Mr. Cleveland Abbe, the Chairman of the Committee, and the date of May, 1879. It draws attention to many of the causes calling for the establishment of accurate time, and the

* See page 27.

attempts made since the establishment of the electro-magnetic telegraph to make the notation of time synchronous. While pointing out that this result had been obtained in Great Britain through the efforts of Professor Airy, Mr. Cleveland Abbe gave a list of the various observatories on this continent which are in possession of the necessary apparatus and force proper to furnish astronomically accurate time by telegraph. Writing in February, 1880, while giving the resolution adopted by the society, recommending the adoption of accurate time by telegraph from an established astronomical observatory, Mr. Cleveland Abbe points out that the subject of accurate time had been taken up by the Horological Bureau of the Winchester Observatory of Yale College, and that the most perfect apparatus had been received for the purpose of distributing New York time with the highest degree of uniformity and accuracy.

Mr. Cleveland Abbe's own remarks on the subject are of high value. He forcibly points out the difficulties and inconveniences under which railway operations in America labour from the want of a proper system of time. To show this fact in greater force, he gives the seventy-four standards then followed. These several standards he proposed to set aside and replace by standards each differing one hour, or 15° of longitude.

While recommending this course, the Report sets forth that the change could only be regarded as a step towards the absolute uniformity of all time-pieces, and the Society passed resolutions, that absolute uniformity of time is desirable; that the meridian six hours west of Greenwich should be adopted as the National Standard to be used in common on all railways and telegraphs, to be known as "Railroad and Telegraph Time;" that after July 4th, 1880, such uniform Standard Time should be the legal standard for the whole country, and that the State and National Legislatures should be memorialized on the subject.

Mr. Cleveland Abbe in this report alluded to the previous proceedings of the Canadian Institute.

The active sympathy of the Marquis of Lorne greatly aided the movement of Time-reform in its early stages. In 1879, in his official position as Governor-General, he had been the recipient of the papers published by the Canadian Institute, and had transmitted them to Great Britain, and through the Imperial Government to the several European centres. In 1880, it was learned that the

Report to the American Metrological Society, above alluded to, would shortly be issued. Accordingly, advance copies were obtained from New York, and, together with additional papers issued by this Institute,* they were transmitted by His Excellency to the following European Societies, and the special attention of their members was directed to the documents themselves:

1. The Institut de France ..... Paris.
2. Société de Géographie ..... Paris.
3. Société Belge de Géographie ..... Brussels.
4. Königliche Preussische Akademie der Wissenschaften. Berlin.
5. Gesellschaft für Erdkunde ..... Berlin.
6. Kaiserliche Akademie der Wissenschaften ..... Vienna.
7. K. K. Geographische Gesellschaft ..... Vienna.
8. Nicolaevskaia Glavnaia Observatoria ..... Pultowa.
9. Imper. Rousskae Geograficheskoe Obschestou ..... St. Petersburg.
10. Imper. Akademia Nauk ..... St. Petersburg.
11. Société de Géographie ..... Geneva.

By this means attention was obtained for the subject in Europe, and when I submit evidence of the fact, I think you will agree with me, that no little of the success which has attended the movement is owing to our late Governor-General. We must all acknowledge how much we are indebted to him for the great personal interest he has always shown on the subject. We are certainly warranted in forming the opinion, that the dissemination of these papers, under such distinguished auspices, awakened attention to the arguments they contain, and prepared the way for the subsequent action taken at the International Geographical Congress at Venice, at the Geodetic Congress at Rome, and more recently at the Conference at Washington.

Mr. Wilhelm Förster, director of the Berlin Observatory, enters into the subject at length in a paper "Zur Beurtheilung Einiger Zeitfragen, insbesondere gegen die Einführung einer deutschen Normalzeit." [A Review of some considerations on Time, especially against the introduction of German National Uniform Time].

Mr. Förster proceeds to say: The British Government is now transmitting, through its representatives, although at the same time it declares itself neutral, a proposition which has been published by a society of scientific men in Canada, which aims at the establishment

* See Communications printed with this.

of a cosmopolitan normal datum (Prime Meridian) and of Universal Time, and also the establishment of 24 meridians of an hour apart, by which local time will be absorbed. The first proposal Mr. Förster describes as an important sign of the times and evidently favours it.

He strongly protests against the establishment of a National German Time; but for railway business, and for such matters of communication as require precision, also for the form of expression of all scientific relations to time, Mr. Förster points out that a Universal Time common to the whole world is to be recommended.

Dr. G. von Boguslavski, in the *Verhandlungen der Gesellschaft für Erdkunde*, (Transactions of the Geographical Society of Berlin), commends the new scheme as it has been put forth in the Canadian Institute papers, and foretells that it will be a matter of fact in a short time.

Col. Aden, Director of the Military School, Belgium, has two papers in the *Bulletin de la Société Belge de Géographie*. He supports the proposal to establish Universal Time, and expresses the opinion that longitude throughout the world should have a common notation, dating from one universally accepted Prime Meridian.

Col. Wauverman, President of the Geographical Society of Antwerp, in the Bulletin of that society, 1882, advocates the change, and with ability meets the arguments raised against it, showing them to be groundless and arising from a want of thoroughly understanding the question.

In Spain, the proposals have met with full support. All the papers issued by the Canadian Institute have been translated and published in a pamphlet of 80 pages by the Revista General de Marina. The translator, Don Juan Pastorin, an officer of the Spanish navy, is warm in his commendation of the scheme, and takes a wise and comprehensive view of the whole question. The Spanish Government secured the advantage of this gentleman's services as Delegate to the Washington Conference.

M. Otto Struve, the well-known Astronomer and Director of the Imperial Observatory, Pultowa, reports on the papers transmitted by Lord Lorne to the Imperial Academy of Science, St. Petersburg. He gives his adherence to the establishment of Universal Time, based, as suggested, on a Prime Meridian common to the whole globe, and strongly advocates counting the hours in one series up to twenty-four.

In England, the Royal Society considered favourably both the

establishment of a Universal Time and the determination of a common Prime Meridian. While the present Astronomer Royal, Mr. Christie, takes a favourable view of the question, his predecessor, Sir G. B. Airy, reported unfavourably. The report of the Astronomer Royal for Scotland, Prof. Piazzi Smith, is decidedly adverse. These documents have been transmitted to the Institute.*

In Italy, the Italian Geographical Society has given its countenance to a work by Mr. Fernando Bosari, who, in a pamphlet of 68 pages, reviews the whole question at length, and lays down three principles: 1. The determination of a Zero-meridian; 2. The establishment of Cosmopolitan Time based upon it; 3. The notation of the hours from 1 to 24 in a continuous series.

The question of Universal Time and the selection of a Prime Meridian is discussed with ability in a paper published by M. Thury, professor at the University of Geneva.

At the meeting of the Association for the Reform and Codification of the Laws of Nations at Cologne, Prussia, in 1881, the question of regulating time on the new system was considered and resolutions moved.

In the same year (1881), the subject occupied the attention of the International Geographical Congress at Venice, at which a Delegate from the Canadian Institute attended. The general question was warmly discussed, and resolutions adopted. The appointment of an International Conference to meet at Washington, specially to consider the question, was then suggested by the Canadian Delegate, and warmly supported by gentlemen representing the Government and scientific societies of the United States.* The President of the Congress communicated the resolutions to the Italian Government, and Prince Teano, on behalf of the Italian Government, undertook to conduct the official correspondence. Out of this appears to have sprung the important discussion at the meeting of the International Geodetic Association at Rome, in October, 1883, when the utility of Universal Time was recognized, and a special International Conference for the establishment of a Zero-meridian for Longitude and Time recommended.

Returning to this side of the Atlantic, the question of regulating time for railway, telegraph, and civil purposes generally, was considered at the Convention of the American Society of Civil Engineers,

* See Documents printed with this.

held at Montreal, June 15, 1881, and a committee of men engaged in the management, and familiar with the economy of railways, appointed to examine the question. The committee has reported from time to time. They recognized that a proposition to reform the general time system of the country was a problem beset with difficulties, but it did not appear to them insolvable. It was felt, however, that the question affected so many interests that any change could only be effected by general concurrence.

To attain the end proposed by this society, the papers bearing on the question were printed, and a scheme modified on the proceedings of the Canadian Institute was drawn up, under the title of "Cosmopolitan scheme for regulating time."

I may briefly recall the features of the scheme.

There should be one standard of absolute time, a Universal Day, based on the mean solar passage, at one particular meridian, the Prime or initial meridian for computing longitude. This Prime Meridian, together with the Universal Day, to be observed by all civilized nations.

There should be 24 secondary or Hour-meridians established, 15 degrees of longitude apart, beginning with the Prime Meridian as zero.

To distinguish the Universal Day from local days, it should bear the title of "Cosmic Day." *

Cosmic Time is intended to be used to promote exactness in chronology, and to be employed in astronomy, navigation, meteorology and in synchronous observations throughout the world. To be employed in ocean telegraphy and generally in all operations non-local in character.

The several twenty-four Meridians to be used as standards for local time around the globe. Applying the system to North America, the effect would be to reduce the standards to four or five, as suggested by the Metrological Society.

A circular, dated March 15th, 1882, signed by Mr. John Bogart, the Secretary of the American Society of Civil Engineers, was for-

* [NOTE.—I may remark, that the designation "Cosmic" was first suggested, independently, by two Canadian gentlemen widely separated, by Mr. R. G. Haliburton, then in Algiers, and by Mr. Thomas Hector, of Ottawa. The etymology commends the use of the word. It has been accepted by a number of societies and by many individuals as appropriate and applicable.]

warded to the leading men in railway direction, either as general managers, superintendents or engineers, and to men of scientific attainments throughout the United States and Canada. The papers thus circulated contained eleven questions, and categorical replies were invited to them.

Replies were received and reported on at a Convention of the Society, held in Washington on the 17th May, 1882. The scheme submitted was generally and cordially approved.

An emphatic and unanimous opinion was expressed, that there should be established as early as possible a comprehensive system of Standard Time for North America.

Of those who replied to the queries, ninety-five per cent. favoured the idea that there should be a common agreement between the Standards of Time in all countries. That while we must primarily look to our own convenience on this continent, it is proper to aim at eventually attaining general uniformity among all nations.

Seventy-six per cent. were in favour of reducing the Standards in North America so that they would differ only by intervals of one hour, and ninety-two per cent. were in favour of a notation of the hours of the day in a single series from 1 to 24, instead of in two divisions, each of twelve hours.

The character of the replies received indicated that a remarkable unanimity of opinion prevailed in every section of the continent heard from. The Convention accordingly resolved that an attempt should be made to obtain European concurrence to the selection of a Prime Meridian on which a Time-system could be definitely based. But, failing to obtain this recognition, the people of the Western Continent should determine a Zero-meridian for their own use and guidance.

It was thereupon resolved to petition the Congress of the United States to take the matter into consideration. The American Meteorological Society about the same time adopted a similar proceeding. The consequences were that a Joint-resolution of the House of Representatives and the Senate was passed, authorizing the President of the United States to call an International Conference to fix on and recommend for universal adoption a common Prime Meridian to be used in the reckoning of Longitude and in the regulation of Time throughout the world.

On the meeting of the American Association for the Advancement

of Science in Montreal, in July, 1882, the subject was brought forward, and all the documents were submitted and discussed. It was agreed that the Association should co-operate with other bodies in furtherance of the movement.

On two occasions the Royal Society of Canada has had its attention directed to the matter, and this body has assisted in furthering the determination of the problem by its co-operation and by correspondence with the Government.

While some delay took place in summoning the International Conference by the President, in consequence of diplomatic correspondence on the subject, the question was ripening on both sides of the Atlantic for concerted action. Indeed, a decision with respect to the regulation of local Time was anticipated by the Railway authorities in North America, who adopted the system of Hour-standards which had been prominently brought forward as described.

On November 18th of last year (1883) the new system of regulating railway Time on this continent came into operation. There had been several preliminary meetings of railway managers; the last meeting was a Convention held in Chicago the previous October, and it was then determined immediately to carry out the change.

Mr. W. F. Allen, the secretary of this Convention, who also took a prominent part in effecting the adoption of the change, has given a history of the events leading to it. Upon this gentleman mainly fell the labour of arranging details, and he executed the difficult duties assigned to him with consummate ability. In the words of the historian, the transition from the old to the new system "was put into effect without any appreciable jar, and without a single accident occurring." According to this authority the first newspaper to advocate some change was the *Railroad Gazette* for April 2, 1870, and it is claimed that as early as 1869 Prof. Charles F. Dowd, Principal of Temple Grove Ladies' Seminary, Saratoga Springs, proposed a system of meridians based on the meridian of Washington at intervals of one hour, by which railways should be operated, and that an expression of his views was placed in the hands of the President of the New York and Canada Railroad. The proposition appears to have attracted attention in the *Travellers' Official Guide* of 1872. In 1873 it was brought before the Railway Association of America, not now in existence. A committee was appointed to examine into its merits; they failed to recognize its necessity, and

recommended that the question of National Standard Time for use on Railways be deferred until it more clearly appeared that the public interests called for it.

Mr. Dowd's efforts to introduce a National Standard Time to meet the difficulties which were being developed were at the time imperfectly appreciated. He, however, has had the satisfaction of seeing a scheme unanimously accepted, and put in operation, which in essential features does not materially differ from that which he advocated; and he himself attended at the meeting of the American Metrological Society, and took part in the proceedings when the details of the new Time arrangements were officially narrated.

Prominent among those who have earnestly laboured to advance the movement of Time-reform is the distinguished President of Columbia College, New York. Dr. Barnard has from the first taken the deepest interest in the question, and few men have done so much to bring it to a practical issue. In the proceedings of the American Metrological Society for 1881 will be found a paper prepared by Dr. Barnard in 1872, and presented to an association which has since assumed an international character, and is known as the association for the Reform and Codification of the Laws of Nations. In this paper Dr. Barnard recommends the selection of Greenwich as the Prime Meridian for the world, and he submits the views he held at that early date, which at this hour are of peculiar interest. He points out that "it is becoming a matter of greater importance every day that there should be established some universal rule for defining the calendar day for all the world."

I have alluded to the valuable report of Professor Cleveland Abbe, of the United States Signal Service, to the Metrological Society, and I cannot deny myself the pleasure of acknowledging the services of the gentlemen with whom I have been associated on the special committee on Standard Time of the American Society of Civil Engineers, Mr. Charles Paine, of New York; Mr. Theodore N. Ely, of Altoona, Pennsylvania; Mr. J. M. Toucey, of the Hudson River Railway; Professor Hilgard, Coast Survey, Washington; Professor T. Egleston, of Columbia College; General T. G. Ellis, of Hartford, now unfortunately deceased, and Mr. John Bogart, Secretary of the Society,

The American Society of Civil Engineers, since meeting in Montreal, in 1881, has made persistent and continuous efforts in the common interest to advance the movement of Time-reform, having

greatly aided in bringing about the important change carried into effect a year ago. This Society is now directing attention to a reform of scarcely less importance, the notation of the hours of the day. At the Buffalo convention in June last, this particular question received prominent consideration in the address of the President, as well as in the report of the special committee.* Since that date a correspondence has taken place between the Secretary and the railway managers in the United States and Canada. Already replies have been received from the representatives of some sixty thousand miles of railway, ninety-eight (98) per cent. of whom have given expression to their sympathy with the movement, to abandon the old practice of halving the day, designating the two sets of twelve hours by the abbreviations A.M. and P.M., and are prepared to adopt a simple notation of 1 to 24 in a single series. The great telegraph interests of the country are likewise in full sympathy with it. The President of the Western Union Telegraph Company, Dr. Norwin Green, states that their telegraphic traffic is equal to the transmission of forty-four million messages a year, and the general adoption of the 24 o'clock system (as it has been designated), would be cordially welcomed by telegraphers. It would reduce materially the risk of errors, and to the company over which he presides, he says it would save the transmission by telegraph of at least 150,000,000 letters annually.

The branch literature bearing on the two questions of Universal Time and the establishment of a Prime Meridian, has been enriched by a series of papers which have appeared during the past year in the *International Standard*, a magazine published in Cleveland, Ohio. These papers are by the following gentlemen connected with

* In "Nature" (London) of November 13th, the following appears:—"However long the "use of the 'a. m.' and 'p. m.' for distinguishing the two halves of the civil day may survive, "it seems probable that the more rational method of counting the hours of the day continu- "ously from midnight through twenty-four hours to the midnight following, may before long "come into use for a variety of purposes for which it is well adapted, even if it should not yet "be generally employed. It seems proper, therefore, to consider in what way ordinary watches "and clocks could be best accommodated to such a change in the mode of reckoning. To place "twenty-four hours on one circle round the dial, instead of twelve hours, as at present, seems "the most natural change to make; but in addition to a new dial, it would involve also some "alteration in construction, since the hour-hand would have to make one revolution only in the twenty-four hours instead of two. And there would be this further disadvantage, that the "hours being more crowded together, the angular motion of the hand in moving through the "space corresponding to an hour would be less—in fact, one-half of its present amount." The remedy pointed out in "Nature" is extremely simple. It is the same as that recommended by Committee on Standard Time of the American Society of Civil Engineers, who reported at Convention of the Society at Buffalo in June (1884) as follows:—"It is proposed to adapt

the International Institute :—Rev. H. G. Wood, of Sharon, Pennsylvania ; Professor C. Piazzi Smyth, Astronomer Royal for Scotland ; Professor John N. Stockwell, Astronomer, Cleveland ; Mr. Jacob M. Clark, C.E., New York ; Mr. William H. Searle. Pennsylvania ; the late Abbé F. Moigno, Canon of St. Denis, Paris ; Commodore Wm. B. Whiting, U. S. Navy ; Mr. Charles Latimer, C. E., Cleveland ; and others.

It will be seen from what I have submitted, that the proceedings have neither been few nor without success, and that since this Institute published the first issue of papers on Time and Time-reckoning, the subject has received much attention on both sides of the Atlantic. Societies with kindred pursuits, men of recognized merit in the scientific world, have turned to its examination and aided in its development. Some few men have acted in concert. The labours of others have been independent. Some of these names I have been able to record, but I fear that I neglect to include many of eminence because they are not known to me. It is this varied and widely diffused effort which has rendered possible the realization of the practical results which I have the gratification to record, and all

" clocks and watches now in use to the change by inscribing on the existing dials the new " numbers of the afternoon hours – thirteen to twenty-four (13 to 24) inclusive—as in the Plate " No. I.

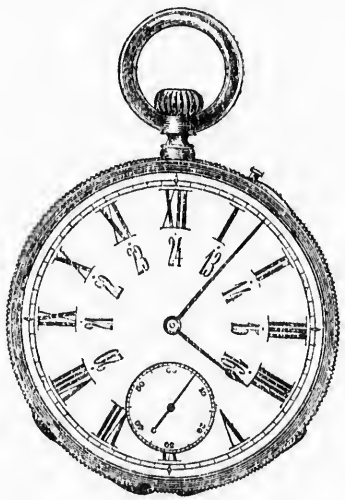

Plate No. I.

The only practical difficulty to be overcome is met by the simple expedient of placing on

the members of this Society must equally join in the common satisfaction in the measure of success which has been achieved.

Six years back, when the subject was discussed in this Hall, there were probably not a few who viewed the propositions then submitted as merely fanciful theories. Others, who did not refuse to recognize their bearing, entertained the feeling that many grave difficulties presented themselves to interfere with any successful attempt to reform or modify usages so ancient as the computation of time. But the Institute, as a body, was hopeful. The action taken by the Council to extend the field of discussion and awaken the attention of foreign communities, evinced confidence, and we may now ask, was this confidence justified? What are the facts to-day? Twelve months have passed since an important change in the notation of Railway Time was made with general approval throughout the length and breadth of North America; a revolution in the usages of sixty millions of people has been silently effected and with scarcely a trace that it has happened. That proceeding has been followed by events of equal importance. On the 1st of October last a body of accredited Delegates from the different nations, on the invitation of the President of the United States, met in Conference to consider the problem

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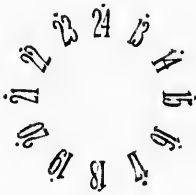
"the face of the watch or clock a secondary dial, showing the new afternoon hours in Arabic "numerals within the present Roman figures.

Plate  No. 2.

"Plate No. 2 shows the secondary dial. It must be of thin material; and it has been "found that made simply of paper and secured to its position by any gum which will adhere to "an enamelled surface, the object is attained without any further alteration of the watch or "clock.

"The Committee is aware that these seem trifling matters to bring under the notice of the "Convention, but questions of great moment not seldom hinge on small details. It is evident "from what has been set forth, that every person in the community may, at the cost of a few "cents in each case, adapt his watch to the 24 o'clock system.

"The Committee accordingly repeat their conviction, that with the disappearance of the "only practical difficulty at an insignificant cost, there is nothing to prevent the Railway "authorities and the community at large adopting the change as soon as they become alive to "its advantages."

first submitted to the world by this Institute. The delegates were the representatives of twenty-five (25) civilized nations. The Conference continued during the whole month of October, and, as a body, they came to conclusions affecting all peoples living under our theories of civilization.

It was early understood that a determination with respect to Universal Time was not possible without the general recognition of a Prime Meridian. Hence the importance attached to its choice, that it should be universally accepted.

For many years attempts have been made to effect the establishment of an initial meridian recognized in common by all nations, but every attempt hitherto had proved completely unsuccessful. It is therefore the greater cause for congratulation, that the efforts of the Washington Conference have succeeded in its determination.

The discussions of the Conference were long, and being carried on in different languages, could not have been of equal interest to all present. Translations became necessary, so that all the Delegates might equally understand the propositions which were daily submitted. This necessary course prolonged the sessions and multiplied the adjournments. At last, however, the choice of a Prime Meridian was obtained. The following resolution was passed, the Delegates voting by nations:

"*Resolved*, That the Conference proposes to the Governments here represented, the adoption of the meridian passing through the centre of the transit instrument at the Observatory of Greenwich as the initial meridian for longitude.

The above resolution was adopted by the following vote:

In the affirmative:

AUSTRIA,	MEXICO,
CHILI,	NETHERLANDS,
COLOMBIA,	PARAGUAY,
COSTA RICA,	RUSSIA,
GERMANY,	SALVADOR,
GREAT BRITAIN,	SPAIN,
GUATEMALA,	SWEDEN,
HAWAII,	SWITZERLAND,

ITALY,	TURKEY,
JAPAN,	UNITED STATES,
LIBERIA,	VENEZUELA.

In the negative:

SAN DOMINGO.

Abstained from voting:

FRANCE AND BRAZIL.

AYES 22. NOES 1.

There was less difficulty and even greater unanimity displayed when the consideration of Universal Time was submitted. The Conference adopted the principle of a Universal Day without a single negative vote. The resolutions carried are substantially in accord with the essential principles, if not with the precise features of the proposals set forth in the proceedings of the Canadian Institute, published in 1879.

The resolution defining the Universal Day reads as follows: "*Resolved*, That this Universal Day is to be a mean solar day; is to begin for all the world at the moment of mean midnight of the initial meridian, coinciding with the beginning of the civil day and date of that meridian, and is to be counted from zero up to twenty-four hours."

This definition, taken in conjunction with the other resolutions of the Conference, is fraught with important consequences.

When it is mean midnight at Greenwich, that moment it is mean noon at the meridian 180° from Greenwich, as indicated by the solar passage. Hence the Anti-Prime Meridian practically becomes the Time-zero for the world.

The initial instant of the twenty-four hours of each successive Universal or Cosmic Day is the moment of mean solar passage on the Anti-Prime Meridian. The first hour of the Cosmic Day is at the solar passage on the meridian 15° westward; this then becomes the 1st Hour Meridian. The second hour of the Cosmic Day is at the solar passage on the meridian 15° still further westward; this becomes the 2nd Hour Meridian. And so on in turn, each meridian which is an exact multiple of 15° from the Time-zero becomes an Hour Meridian corresponding in number with the numbers of the successive hours of the Cosmic Day.

The twenty-four Hour Meridians so determined come in the following order, viz. :

LONGITUDE EAST AND WEST.	HOUR MERIDIANS.	COSMIC TIME AT SOLAR PASSAGE.
180° Anti-Prime Meridian	Zero	0 hours 0 minutes.
165° East	1st Hour Meridian	1 o'clock.
150° East	2nd " "	2 "
135° East	3rd " "	3 "
120° East	4th " "	4 "
105° East	5th " "	5 "
90° East	6th " "	6 "
75° East	7th " "	7 "
60° East	8th " "	8 "
45° East	9th " "	9 "
30° East	10th " "	10 "
15° East	11th " "	11 "
0° The Prime Meridian.	12th " "	12 "
15° West	13th " "	13 "
30° West	14th " "	14 "
45° West	15th " "	15 "
60° West	16th " "	16 "
75° West	17th " "	17 "
90° West	18th " "	18 "
105° West	19th " "	19 "
120° West	20th " "	20 "
135° West	21st " "	21 "
150° West	22nd " "	22 "
165° West	23rd " "	23 "
180° Anti-Prime Meridian	24th " " or zero	24 "

Thus the exact position of the twenty-four secondary or Hour Meridians is practically determined, and provision is thereby made for extending around the globe the Hour-system of regulating time which has been adopted with so much advantage in America.

These Hour Meridians, so designated, completely establish the relation between Cosmic time and longitude. Once every day the relationship will be prominently brought under the notice of every individual. Everyone, for example, living on the 6th Hour Meridian, will know at noon that it is at that instant six o'clock Cosmic time; or, take the citizens of Toronto, the local time of which is governed by the 17th Hour Meridian; at the hour of noon they will know that it is 17 o'clock Cosmic Time. Invariable time will thus agree with longitude, conversely longitude with time. By this arrangement the earth itself becomes the great Standard Chronometer for all

mankind, and in its daily rotations the passage of the sun at any spot will be the index of Cosmic time.

The resolutions of the International Conference establish a means of reckoning time which promises, in the years to come, to be of the highest advantage to the human family. Cosmic Time, or whatever name may be given to Universal Time applied to civil purposes, is an entirely new feature. It has now obtained recognition by a properly constituted authority, although until recently, I believe, it has remained unconsidered. Astronomers have long had equinoctial time, which is absolute time, dating from an epoch determined by the sun's motion among the stars; beyond this I cannot find any nearer approach to the mention of Universal Time as now understood.

The conclusions of the Conference mark a new era. The civil time of England is adopted as Universal Time. It may be said that Greenwich time is already known on every sea, that it has been carried by British ships wherever British explorers and colonists and merchants have penetrated, but Greenwich time is the local time of Greenwich, and, heretofore, it has always been held as such. Universal time based on the Prime Meridian of the globe, and recognized by the several civilized nations, is an entirely different conception. As the Time of the world common to every nation, it is held that the term "Cosmic" will better express that meaning than "Greenwich." Cosmic and Greenwich time are identical by accident, but the expressions imply two totally different ideas, and known national sensitiveness suggests the good taste and expediency of distinguishing the two ideas by different terms.

I am induced to add a few words in explanation of the principles of Cosmic time.

Time has been the subject of profound thought by many philosophic minds of the past. They have attempted to define it, and their definitions have been manifold. If we view the earth as a whole, and the conditions of the age in which we live oblige us so to view it, I am unable to see that any one of the recorded definitions gives support to the ancient system of keeping count of time which we follow. Our ordinary usages imply that there is an infinite number of times, and they are based on the principle that time is dependent on local situation. Nothing can be more erroneous and misleading. It is this false principle entering into every detail of daily life which has led each insignificant locality on the circumference of the globe to

claim the right to have its own time. It is self-evident that time is in no way dependent on locality, and I will quote on this point but one authority, the great Sir Isaac Newton. "Absolute true and mathematical time of itself, and from its own nature, flows equally without regard to anything external."

Our finite minds are incapable of understanding fully what time is, but this much is perfectly clear to our reason. Time is a measureable quantity, it may be termed a flowing magnitude, and only as *one* such magnitude is it conceivable. A distinct and separate flow of time in each of the myriad localities throughout the Universe is perfectly inconceivable. If time be anything it is a *unity* and not a *plurality*. The cardinal principle of Cosmic Time is *unity*, and with *unity* as a fundamental idea of time it must be held that the Cosmic system is the only sound principle of reckoning, and that as the area of civilization broadens, it must in the end be recognized as applicable everywhere and for all purposes.

The conclusions of the International Conference are fruitful of results of high importance. They may be said to point to the opening of a new chapter in the world's annals. They make provision for a complete cessation of ambiguity in hours and dates. By Cosmic Time all events whatsoever will be systematically arranged according to their proper chronological order. The calendar days the world over will begin at the one initial instant, and clocks will strike the same hour at the same moment in all longitudes.

But the new system can only be gradually introduced. The majority of mankind have firmly fixed ideas with regard to the passage of the day and the numbers of the hours by which their social habits are regulated. A proposal suddenly to change the old familiar succession of the hours will be misunderstood. The influence of custom is always powerful under any aspect. It is anticipated that this influence will be the one serious obstacle to be overcome. The belief, however, may be permitted that the change will be rendered easy when men understand that the numbers of such hours have been arbitrarily chosen; that there is no necessary connection between them and the position of the sun in relation to the earth in its daily rotation, and that whatever numbers may distinguish the twenty-four divisions of the day, the recurring phenomena of light and darkness will always regulate sleeping, waking, eating, and working, and all the routine of life in every locality. Noon has heretofore been

associated in our minds with the hour of 12, but among the Jews noon was the 6th hour, and astronomers have almost invariably recognized it as the 24th hour. For a year back throughout the United States and Canada the agreement between 12 o'clock and precise noon has been at an end. It may be said that, except on four or five meridians, 12 o'clock is nowhere coincident with mean solar noon. This departure from an old usage must tend to unloosen the traditional idea that the mere numbers of the hours have any necessary connection with the position of the sun in the heavens. If this innovation has any effect it must help to pave the way for still further and more important changes than have yet been introduced. The Meridians by which time is regulated in North America are 5, 6, 7 and 8 hours of longitude west from the Prime Meridian. It will only be necessary to move forward our clocks 5, 6, 7, and 8 hours respectively to bring them all into agreement with the time of the Prime Meridian, which is Cosmic Time, and thus obtain complete uniformity. It cannot, however, be looked for that Cosmic Time will at once be adopted in ordinary affairs. A generation probably will pass away before it will obtain general acceptance. The difficulties to be overcome cannot be ignored, and we may assume that it will only be step by step that the change will be made, the more advanced nations taking the lead. On this continent positive progress has been made, to be succeeded before long, I do not doubt, by another advance in public opinion, and a general acceptance of the principles recently recognized. In the course of years the prejudices engendered by inherited customs will be greatly modified, and the masses will gradually have their minds familiarized with new ideas. It is a significant fact that the principles of the new system should be unanimously recommended by delegates from all civilized nations. I do not doubt that the several peoples they represent will sooner or later understand that one uniform reckoning of time for every purpose throughout the globe is the only rational system, and the one notation which in coming years will properly meet the necessities and requirements of mankind.

In these remarks I have narrated the events which have taken place on both sides of the Atlantic to influence and determine the conclusions which, a few weeks back, the President submitted to the Congress of the United States.

On this occasion I cannot think that I am entirely wrong when I

venture to congratulate the Canadian Institute on the part which it has taken in the solution of this problem. It stands among the Societies who first considered this comparatively new question. Indeed, it may be claimed that the Institute is to some extent the pioneer Society in awakening the world to the advantages to be derived from the establishment of Cosmic Time..

In conclusion, I will avail myself of the words of an early President of the Institute, whose portrait for more than thirty years has adorned the hall in which we are now assembled. Referring to the results already effected in Time-reform and the prospects for the future, General Sir Henry Lefroy, in his address at the late meeting of the British Association in Montreal, remarked: "Whether we conceive its educational tendency or its influence on the future intercourse of unborn millions, it is a somewhat remarkable evidence that agreement upon questions of general concern is not that unattainable thing which we are apt to consider it."

After the reading of Mr. Fleming's paper, the following Resolution was moved by Dr. E. A. Meredith, seconded by Mr. W. H. VanderSmissen, and passed:

"That the meeting, considering this an exceptional case, desire to tender a cordial vote of thanks to Mr. Sandford Fleming, C.M.G., for his interesting communication on the subject of 'Cosmic Time,' and they wish, at the same time, to record their satisfaction that to one of the original members of the Institute is due the honour of being the first to bring prominently before the scientific world, through the medium of the Journal of the Institute, the important subject of Time Reform, and the adoption of uniform or Cosmic Time."

COSMIC TIME.

SUPPLEMENTARY PAPERS,

COMMUNICATIONS AND REPORTS,

IN THE POSSESSION OF

THE CANADIAN INSTITUTE.

SUPPLEMENTARY PAPERS.

MEMORIAL OF THE CANADIAN INSTITUTE TO HIS EXCELLENCY THE GOVERNOR-GENERAL OF CANADA, SUBMITTING PAPERS ON TIME-RECKONING AND A PRIME MERIDIAN, READ DURING THE SESSION 1878-79.

To His Excellency, the Right Honourable SIR JOHN DOUGLAS SUTHERLAND, *Marquis of Lorne, one of Her Majesty's Privy Council, Knight of the Most Ancient and Most Noble Order of the Thistle, and Knight Grand Cross of the Most Distinguished Order of Saint Michael and Saint George, Governor-General of Canada, and Vice-Admiral of the same.*

The memorial of the Council of the Canadian Institute

RESPECTFULLY SHEWETH :

That the Canadian Institute, established in Toronto for a period of thirty years, has specially aimed at promoting scientific study and research; and by means of its Journal of Proceedings has maintained communication with men of science in Europe and America.

At meetings of the Institute, during the present session, communications have been submitted to it by one of its members, Mr. Sandford Fleming, C. M. G., with the special object of determining a First or Prime Meridian, common to all nations; and promoting the adoption of a universal system of Time-reckoning, adapted alike to the requirements of an uniform historical record, and to the novel requirements of civilization, consequent on the rapid extension of railway and telegraphic lines over the globe.

While the geographical circumstances of Canada invest this subject with peculiar interest to the Dominion, its importance is not limited to Canada. In every civilized country, circumstances have tended in recent years to demonstrate the desirableness of adopting some uniform system of notation of time and space; and, as your Excellency will see by the papers herewith transmitted to you, the attention of various scientific bodies, both in Europe and America, as well as of your memorialists, has been directed to this important subject.

Your Memorialists have accordingly welcomed, with special satisfaction, the suggestion by one of their own members whose practical experience, especially in his trans-continental surveys as Chief Engineer of the Canadian Pacific Railway, peculiarly fits him for the task: the suggestion of a Prime Meridian, free from the objections hitherto urged against other propositions, and so offering an accept-

able solution of a problem of international importance, which has long engaged the attention of leading geographers and astronomers both of Europe and America.

As the determining one initial Meridian for computing longitude, common to all nations, is an object of special interest to Great Britain, as the foremost maritime nation of the world, as well as to Canada and all the Colonies of the Empire; the Council of the Canadian Institute have hoped that the subject will not seem unworthy of your Excellency's consideration.

They respectfully invite your attention to the matter as set forth in the accompanying papers; and in view of the important international interests involved, they beg leave, very respectfully, to ask your Excellency to bring the subject under the notice of the Imperial Government, and to use your high influence to direct the attention of official and scientific authorities in Great Britain, and those of foreign Governments, to it.

The peculiarly favourable position which your Excellency occupies as the Governor-General, under Her Majesty, of a Dominion commanding both the Atlantic and Pacific coasts of the Continent of North America, appears to your Memorialists to furnish special facilities for promoting the simplification of a complex system, admittedly open to well-founded objections; and substituting for it one which not only offers a solution of the evils, but is also extremely simple in its application, and free from the sources of international jealousy which have hitherto neutralized the efforts of scientific men to remedy practical evils which are universally recognized.

And your Memorialists, as in duty bound, will ever pray.

DANIEL WILSON, LL. D., *President.*

WM. OLDRIGHT, M. A., M. D., *2nd Vice-President.*

HENRY SCADDING, D. D., *3rd Vice-President.*

JNO. NOTMAN, *Treasurer.*

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GEORGE MURRAY.

C. B. HALL, M. D.

R. A. REEVE, B. A., M. D.

E. J. CHAPMAN, LL. D.

JAMES LOUDON, M. A.

HIS EXCELLENCY THE MARQUIS OF LORNE, GOVERNOR-GENERAL OF CANADA, TO SIR M. E. HICKS-BEACH, SECRETARY OF STATE FOR THE COLONIES.

[No. 147.]

OTTAWA, 21st May, 1879.

SIR, I have the honour to forward herewith for such action as you may think proper a copy of a Memorial addressed to me from the Canadian Institute, Toronto, together with a pamphlet with respect to the desirability of establishing a "Prime Meridian" to be common to all nations.

I have, etc.,
LORNE.

SIR M. E. HICKS-BEACH, &c., &c.

MEMORANDUM OF THE CANADIAN INSTITUTE, ACCOMPANYING PAPERS TRANSMITTED TO THE IMPERIAL GOVERNMENT BY HIS EXCELLENCY THE GOVERNOR-GENERAL, CANADA, MAY, 1879.

The President and Council of the CANADIAN INSTITUTE (Toronto), having memorialized His Excellency the Governor-General of Canada, respecting the accompanying papers, with the special object of determining a FIRST OR PRIME MERIDIAN TO BE COMMON TO ALL NATIONS, and promoting the adoption of a UNIVERSAL SYSTEM OF TIME-RECKONING, adapted to the requirements of modern progress:

His Excellency the Governor-General, in view of the important international interests involved, has been graciously pleased to bring the subject under the notice of the Imperial Government, in order that the attention of the official and scientific authorities of Great Britain and of foreign countries may be directed to it.

The geographical circumstances of this country invest the question with special interest to the people of Canada, and the peculiar political status of the Dominion may in some respects enable the representatives of Canadian science to mediate, especially between their scientific brethren, in the various countries more immediately interested in the questions at issue. The Council of the Canadian Institute will be glad to receive, and to transmit to all the scientific bodies with which they interchange publications, any communications which may be made to them; and with the view of promoting the objects aimed at, will be happy to collate all comments, suggestions, or expressions of opinion with which they may be favoured.

R. RAMSAY WRIGHT,
Secretary.

CANADIAN INSTITUTE,
Toronto, May, 1879.

PROFESSOR R. RAMSAY WRIGHT, SECRETARY OF THE CANADIAN INSTITUTE, TO HIS EXCELLENCY THE GOVERNOR-GENERAL, CANADA.

CANADIAN INSTITUTE, TORONTO, June 24th, 1879.

The Secretary of His Excellency the Governor-General, Ottawa.

SIR,—Referring to the papers on Time-reckoning and the selection of a Common Meridian, which His Excellency has been pleased to bring under the notice of the Imperial Government, in order that the attention of the Scientific and other authorities of various countries may be directed to the subject,

I now beg to forward to you additional copies, in order that they may be transmitted, through the Imperial Government, to the proper official authorities and the principal Scientific Societies in Great Britain and the Colonies, as well as to the representatives in London of the different countries in the accompanying list.

I am requested respectfully to express the hope that in directing attention to these papers it may be intimated that the Council of the Canadian Institute will be glad to learn how far the solutions of the difficulties referred to may be generally acceptable.

I have the honor, etc.,

R. RAMSAY WRIGHT,
Secretary.

FOREIGN COUNTRIES.

France	8 copies.
Germany	8 "
Italy	8 "
Norway and Sweden	8 "
The United States	8 "
Russia	8 "
Austria	4 "
Belgium	4 "
Brazil	4 "
Denmark	4 "
Japan	4 "
Netherlands	4 "
Portugal	4 "
Spain	4 "
Switzerland	4 "
Turkey	4 "
Greece	4 "
China	4 "

IN GREAT BRITAIN.

The Admiralty The Astronomer Royal, Greenwich The Astronomer Royal for Scotland Royal Astronomical Society Royal Geographical Society Royal United Service Royal Society	50 copies.

HIS EXCELLENCY THE MARQUIS OF LORNE, GOVERNOR-GENERAL OF CANADA, TO SIR M. E. HICKS-BEACH, COLONIAL SECRETARY, LONDON.

[No. 174.] OTTAWA, July 12th, 1879.

SIR,—With reference to my despatch No. 147, of the 21st May last, transmitting a copy of a pamphlet, entitled "Time-reckoning and the Establishment of a Prime Meridian," I have the honour to forward herewith a further communication, June 24th, 1879. from the Canadian Institute at Toronto, concerning additional copies of the papers in question, and requesting that they may be distributed in accordance with the list appended.

If you see no objections I should be much obliged if you would kindly give effect to the wishes of the Institute.

I have, etc.,

LORNE.

SIR M. E. HICKS-BEACH, &c., &c.

SIR M. E. HICKS-BEACH, COLONIAL SECRETARY, LONDON, TO THE MARQUIS OF LORNE, GOVERNOR-GENERAL, CANADA.

[Canada, No. 342.] DOWNING STREET, 15th October, 1879.

MY LORD,—In my despatch, No. 173, of the 11th of June, I acknowledged the receipt of your despatch, No. 147, of the 21st of May, inclosing a Memorial from the Canadian Institute of Toronto, together with a Pamphlet, entitled "Time Reckoning and the Establishment of a Prime Meridian," which the memoralists desired to be brought to the notice of Her Majesty's Government as well as of Scientific Societies in Great Britain, and to be submitted also for the consideration of the Governments of Foreign Powers.

2. I have now to acknowledge your later despatch, No. 174, of the 12th of July, inclosing a further communication from the Canadian Institute, forwarding additional copies of the Pamphlet, which they request may be distributed in accordance with a list thereto appended.

3. It has been the custom of Her Majesty's Government to abstain from interfering with recognized usages in questions of social importance until the spontaneous use of any novel system that may be introduced in such matters has become so extensive as to make it desirable that authoritative regulations should be sanctioned with regard to it, and it does not appear that such a condition of affairs in reference to the subjects of the Memorial has yet arisen.

4. It appears, however, that the memorialists consider it desirable that their views on the question should be extensively ventilated, and in accordance with their application, I have forwarded the Pamphlets which they have transmitted, to the scientific societies named in the list, and I will also request the Secretary of State for Foreign Affairs

to transmit copies of the Pamphlet to the Representatives of Foreign Countries, as desired, and to intimate to them that I shall be happy to forward to the Canadian Institute any communications which may be sent in reply from any Foreign Scientific Institutions to which they may be forwarded, but it must be distinctly understood that Her Majesty's Government are merely transmitting these papers out of courtesy to a Scientific Institution in Canada, and that in doing so, they lend no support to, and assume no responsibility for the views advocated therein.

I have, &c., &c.,
M. E. HICKS-BEACH.

GOVERNOR-GENERAL,
The Right Hon. The Marquis of Lorne, K.T., G.C.M.G., &c.

SIR M. E. HICKS-BEACH, COLONIAL SECRETARY, LONDON, TO THE MARQUIS OF LORNE, GOVERNOR-GENERAL, CANADA.

[Canada, 343.] DOWNING STREET, 17th October, 1879.

MY LORD,—With reference to my despatch, No. 342, of the 15th instant, relating to the pamphlet on "Time Reckoning and the Selection of a Common Meridian," which the Canadian Institute of Toronto has desired to have brought before the notice of various Scientific Societies and of Foreign Governments, I have the honour to transmit to you the accompanying copies of letters received from the Admiralty and from certain of the scientific bodies to whom copies of the Pamphlet were forwarded, in accordance with the wish expressed in your despatch, No. 174, of the 12th of July last.

I request that these documents may be forwarded for the information of the Canadian Institute of Toronto.

I have, &c., &c.,
M. E. HICKS-BEACH.

GOVERNOR-GENERAL,
The Right Hon. The Marquis of Lorne, K.T., G.C.M.G., &c.

SIR G. B. AIRY, ASTRONOMER ROYAL, GREENWICH, TO THE SECRETARY OF STATE FOR THE COLONIES.

(PORTINSCALE, KESWICK),
ROYAL OBSERVATORY, GREENWICH, 18th June, 1879.

SIR,—I have the honour to acknowledge your letter of June 13th, transmitting to me copy of a Memorial, undated, from the Council of the Canadian Institute of Toronto to the Governor-General of Canada, together with a Pamphlet by Mr. Sandford Fleming, which I return herewith, and requesting my observations or suggestions on these documents. I respectfully offer the following remarks:

1. The subject of the Pamphlet is "Time Reckoning and a Prime Meridian common to all Nations," on this matter I advance: First,

that in all countries in which hours are known, the origin of those hours is, approximately, the mean time of local noon. There must thus be introduced a degree of confusion, which the ordinary sense of mankind, by maintaining (in adjustments of public clocks, &c.,) the same mean origin within definite limits, and well defined differences between the indications in territories of other definite limits, has effectually met. Thus the difference between England and Ireland has been fairly met by a difference of 25^m (which would better have been 30^m) between the indications of the public clocks. It is, I believe, certain that this is not the result of legislation, it appears to be merely the result of common sense, guided perhaps by a single personal influence. At Basle (possibly in like manner at other stations) the great systems of the French Railways meet, and there the times in the French States and the German States (I suppose Paris time and Berlin time), are exhibited side by side, and there can be no confusion or difficulty. In the case of the railway from New York to San Francisco, it is merely necessary to frame the Westward train-bills and guard's watches to New York time, and the Eastward train-bills and guard's watches to San Francisco time, with double clocks at every station, naturally there must be a re-adjustment of watches at the end of the journey. Thus, adopting as incontrovertible the idea that every district will refer to visible noon for the origin of its own time, and remarking the extreme facility with which those origins can be linked together, I set not the slightest value on the remarks extending through the early parts of Mr. Fleming's paper. Secondly, as to the need of a Prime Meridian, no practical man ever wants such a thing. If a Prime Meridian were to be adopted, it must be that of Greenwich, for the navigation of almost the whole world depends on calculations founded on that of Greenwich. Nearly all navigation is based on the Nautical Almanac, which is based on Greenwich observations and referred to Greenwich Meridian, and the number of Nautical Almanacs sold annually exceeds, I believe, 32,000 (see the Navy Estimates). But I, as Superintendent of the Greenwich Observatory, entirely repudiate the idea of founding any claim on this. Let Greenwich do her best to maintain her high position in administering to the longitude of the world, and Nautical Almanacs do their best, and we will unite our efforts without special claim to the fictitious honour of a Prime Meridian.* For the mere expression of longitudes, with the limitation that longitude is not to exceed 180° East or West, Greenwich is not inconvenient. But every such consideration yields to historical or other circumstances. Thus, as regards California civilization and time-reckoning (in the count of days of a month)

* The origin of Greenwich Observatory is curious. A Frenchman had a correct idea that longitude at sea might be determined by observations of the moon. He was not received by Louis XIV., but procured introduction to the Duchess of Portsmouth, who placed his scheme before Charles II. and his brother James, both able men in some respects. They adopted it, in essentials, and Greenwich Observatory was founded. The moon is still the most important object of the Greenwich Observatory.

were first carried eastwardly from Europe to California, through the Cape of Good Hope and India (by the Jesuit Missionaries). When the United States advanced westwardly, they who had taken their count westwardly from Europe found one day's difference. The United States have gained the victory in the States. I know not whether the Missions have changed. It is said that the Philippine Islands are still in an anomalous position.

2. As regards the construction of clock-faces proposed by Mr. Fleming to meet the supposed difficulties, I do not believe that they would ever be adopted or used. If they were exposed in shops, I do not suppose that one would be sold.

3. I do not understand, from the terms of the Toronto Memorial, what steps the memorialists wish the Government to take, except "perhaps to direct the attention of official and scientific authorities in "Great Britain, and of Foreign Governments, to it." I do not imagine that Her Majesty's Government are inclined, *mero motu*, to undertake this responsibility.

4. As far as I can understand the usual policy of the British Government in social matters, it has been, to adopt the general sense of the nation in the broad features of any such arrangements, and to give to them that accuracy and uniformity which only a Government can give. Among other matters, I am officially cognizant of the laws and regulations respecting standards of length, weight and capacity, and I believe that the system secured by the policy which I mention is most excellent. The same may be said in regard to Bills of Exchange, Cheques, &c., where rules, suggested by usage, have been adopted and legalized by the Government.

5. I would suggest for consideration, that an answer be given nearly of the following tenor: That Her Majesty's Government, recognizing in some degree the inconveniences described by the memorialists, are not able at present to compare with them the possible inconvenience which might arise from the interference of Government in such a matter. That it has been the custom of Her Majesty's Government to abstain from interfering to introduce novelties in any question of social usage, until the spontaneous rise of such novelties has become so extensive as to make it desirable that regulations should be sanctioned by superior authority. That it does not appear that such extensive spontaneous call in reference to the subjects of the Memorial, has yet arisen. That it appears desirable that the question should be extensively ventilated by the memorialists, and should be submitted by them to the principal Geographical and Hydrographical bodies, including (perhaps with others) the Royal Geographical Society, and the Dock Trustees or other commercial bodies, at London, Liverpool and Glasgow.

I have, &c.,

G. B. AIRY.

The Right Hon. The Secretary of State for the Colonies, &c.

PROFESSOR PIAZZI SMYTH, ASTRONOMER ROYAL FOR SCOTLAND, TO THE COLONIAL OFFICE, LONDON.

ROYAL OBSERVATORY, EDINBURGH, Aug. 30, 1879.

SIR,—I have the honour to acknowledge the receipt of your letter of "August" 30, 1879, transmitting to me copies of a Canadian pamphlet on "Time Reckoning and the selection of a common Meridian," and intimating that Sir Michael Hicks-Beach will be so obliging as to transmit to Canada, through the Governor-General of the Dominion, any observations which I may have to make on the subject. I gladly accept Sir Michael Hicks Beach's obliging offer, and will speedily send a letter for such desirable transmission.

I am, &c., &c.,

PIAZZI SMYTH,

Astronomer-Royal for Scotland.

To Edward Wingfield, Esq., Colonial Office, Whitehall, London.

PROFESSOR PIAZZI SMYTH, ASTRONOMER ROYAL FOR SCOTLAND, TO THE COLONIAL OFFICE, LONDON.

ROYAL OBSERVATORY, EDINBURGH, Sept. 5th, 2879.

SIR,—In further answer to your letter of "August" I have now the pleasure of sending you my remarks on the Time-reckoning Pamphlet transmitted by the Governor-General of the Dominion, and request you to be so good as to present them to Sir Michael Hicks Beach for his obliging promise to be so good as to forward them to the Secretary of the Canadian Institute through the Governor-General of the Dominion.

I am, &c. &c.,

PIAZZI SMYTH,

Astronomer-Royal for Scotland.

To Edward Wingfield, Esq, Colonial Office, Downing Street, London.

ROYAL OBSERVATORY, EDINBURGH, Sept. 5th, 1879.

Remarks on Mr. Sandford Fleming's papers on Time Reckoning and the selection of a Prime Meridian :—

These papers, transmitted now through the Governor-General of the Dominion, are before me for the second time; for they were sent first for an opinion, to be addressed to their author, many months ago by a mutual friend in Halifax, Nova Scotia. I praised them then for their good intentions on a matter of daily-growing importance to mankind, but condemned them for the want of practicality and the unadvisableness of the particular method proposed to be employed; and my opinion is still very much the same.

No matter what beautifully-written schemes any few very learned men may propose in their closets, the world at large, who gain their daily bread by toil of some kind or another, will insist on having, observing, or arranging their working days mainly according to the Sun, in their own locality or Meridian. Local time will never therefore be dispensed with amongst mankind at large. And when, for the convenience chiefly of the travelling portion of the community, the local time of one has to be compared with the local time of many other places, and can be accomplished most easily by one of them being considered superior to, and made the Prime of, the others, the Meridian locality of the greatest number of mankind is certain to be most regarded, and will assuredly prevail, and become the chief of all, as any opinion of a majority invariably in the end overcomes that of a minority. Yet Mr. S. F's proposed Prime Meridian for all mankind is in a part of the world where there are either no inhabitants at all, or, if a few do reside near one end of the line, they are a miserable driblet of wretched Kamschatkan savages, prowling with difficulty for food over snowy wildernesses under the doubtful rule of Russia !

Mr. Sandford Fleming seems to know perfectly well that in making such a proposition he is running full tilt against common sense and universal experience. But then he urges the plea of national jealousies being aroused if the Prime Meridian were to pass through the country of one powerful European nation more conveniently for its inhabitants than for those of another ; so he does them all equally a mischief by making his Meridian convenient to no one ; and proudly holds that the grand object now of advanced civilization is to consult in everything the utmost development of inter-nationality, or the breaking down of all the ancient bounds which have hitherto divided one nation from another, and in fact formed them into nations.

But, pray, who originally made the nations, God or Satan ? Really one would almost think the latter, when certain modern politicians are so perpetually urging upon their countrymen the propriety, nay the very virtue of their doing all they can to destroy those primeval distinctions, and remove them from the face of the earth.

Yet the Bible, which in this country we all profess to believe, tells us in language perfectly unmistakable, that the nations were a directly Divine institution, enacted by God himself ; wherefore, woe indeed to whoever attempts to abolish their distinctions. Some men, no doubt, have tried, but then who, and what manner of persons were they ?

Chiefly members of the dread International Commune which transcends all mere radical politicians in seeking even by blood and fire to destroy most completely the nations, and to form all mankind into one vast, headless society. And that said Commune is utterly atheistic, without any notion of a God.

Just as its parent predecessor, the first French Revolution, after killing off France's Royal Family invited others to do the same while they publicly proclaimed there was no God, declared the Bible to be only an invention of the priests, and claimed the whole earth as the possession of Communistic man, without any superior over him for evermore. But whatever other nations may choose to do, the bulk of the British nation, because it believes the Bible to be the inspired word of God, and obeys Bible teaching, will never be guilty of anything after that Communistic sort, and will never seek to destroy either its Royal Family or its national weights and measures divinely given to the *origines* of its race as an historic heir-loom in the mysterious beginning of time, and in antiquity vastly more remote as well as sublime than any of the names quoted by Mr. Sandford Fleming.

Hence the British nation will be under no perplexity on this abstract subject of time-keeping, though some of its requirements do crop up more and more conspicuously as the world grows older, and the fulness of the Gentiles begins to come in. For, if the nation does really desire to continue to run in the national paths prepared for it by God, and as they may be read off now with increasing distinctness in the sure word of prophecy, it has only to consider what Prime Meridian will best suit its own people, wherever they congregate in the greatest numbers. And it has something of that kind to consider and legislate for at the present moment, as thus:

On the very same principle that for two centuries past, the British have held their Prime Meridian to be that which passes through England, London, Greenwich; so now in this present age, when the hundreds of millions of living souls of India have been given us by Providence for fellow-subjects, the Prime Meridian of the whole nation should, in fairness and justice, be removed from Greenwich, not westward, but eastward. And if the question be next raised, "how far," then due regard to numbers, climate and geographical aptitudes for British life, manufactures and commerce as over-ruled and directed by the only true religion, bring us to the general Meridian of Egypt. And in Egypt more particularly and precisely to the exact Meridian line of that both *ante* and *anti* Egyptian Monument alluded to by Isaiah, viz., the great Pyramid. For that is the pillar "matzaybah," announced by the Messianic Prophet as destined to come forth in the latter day as a sign and a witness to the Lord of Hosts; and it is now found by scientific examination, and weights and measures, proof to contain, conformably with the Bible, religious and prophetic testimony of its own, from before the beginning of any of the nations, to the glorious future of the Anglo-Saxon people, American as well as British. But only for just so long as they obey God in the national paths and within the national bounds which He, with omniscient knowledge of the future through

all its "times and seasons," appointed to them of old, for purposes of His own, in the government of this world, now comparatively near establishment, according to all the more chronological of the Prophets both of the Old and New Testaments.

PIAZZI SMYTH,
Astronomer Royal for Scotland.

THE LORDS COMMISSIONERS OF THE ADMIRALTY TO THE SECRETARY OF STATE FOR THE COLONIES.

ADMIRALTY, 4th October, 1879.

SIR,—With reference to your letter of the 28th of August, covering a Pamphlet advocating the establishment of a Prime Meridian, that should be common to all nations, I am commanded by my Lords Commissioners of the Admiralty to acquaint you, for the information of the Secretary of State for the Colonies, that it does not appear to their Lordships that there is a sufficient demand by the public to justify Her Majesty's Government in attempting to change the existing practice, and that before seriously considering the question, they would be glad to learn that it had been more extensively discussed among the geographical and nautical bodies who are more interested in it.

I am, &c.,
ROBERT HALL.

The Under-Secretary of State, Colonial Office.

SIR M. E. HICKS-BEACH, COLONIAL SECRETARY, LONDON, TO THE MARQUIS OF LORNE, GOVERNOR-GENERAL, CANADA.

(Canada, No. 367.) DOWNING STREET, 13th November, 1879.

MY LORD,—With reference to my despatch No. 343, of the 17th ultimo, enclosing copies of letters received from the Admiralty and certain scientific bodies respecting the pamphlet entitled "Time-Reckoning and the establishment of a Prime Meridian," I have the honour to transmit to you a copy of a further communication on the subject from the Royal Society.

I request that this paper may be forwarded for the information of the Institute at Toronto.

I have, &c.,
M. E. HICKS-BEACH.

GOVERNOR-GENERAL,

The Right Hon. the Marquis of Lorne, K.T., G.C.M.G.

THE SECRETARY OF THE ROYAL SOCIETY, LONDON, TO THE COLONIAL OFFICE.

THE ROYAL SOCIETY, BURLINGTON HOUSE, November 6th, 1879.

SIR,—In reply to your letter dated 28th August, 1879, enclosing copy of a letter from the Secretary of the Canadian Institute, Toronto, with copies of a pamphlet relative to the establishment of a Prime Meridian that shall be common to all nations, I am directed to offer the following observations :—

The President and Council of the Royal Society have taken into consideration the proposals of Mr. Sandford Fleming relative to Time-reckoning and to the establishment of a Prime Meridian, which were forwarded by the Council of the Canadian Institute, with a Memorial, to His Excellency the Governor-General of Canada.

The proposal consists of two parts—(1) The establishment of a system of Cosmopolitan Time, with plans for the ready passage from this to approximate local Time. (2) The choice of a Prime Meridian which should be common to all nations.

The convenience of a system of Time-reckoning which should be common to all the earth is easily seen; while at the same time it is obvious that if such a reckoning be at all generally used, there must be means of readily passing from it to local Time, or at least approximate local Time, which is intimately bound up with the daily business of life.

The means recommended by the author are simple and seem well devised. The difficulty is, of course, to induce the different civilized nations of the world to concur in this or any similar scheme.

With regard to the second point, the establishment of a Prime Meridian common to all nations, the author has adduced strong reasons, founded on convenience, why a Meridian passing through Behring Strait, or nearly so, should be chosen. It happens that a Meridian 180° from that of Greenwich fulfils the condition, and if this were adopted, the change in existing maps, &c., which refer to the Meridian of Greenwich as the Prime Meridian, would not be very serious. The choice, however, of a Prime Meridian, even to the extent of adopting one exactly 180° from a Meridian at present in use as a Prime Meridian, is one upon which the susceptibilities of individual nations might make it more difficult to obtain concurrence than upon the mere adoption of a common system of cosmopolitan Time-reckoning in the abstract.

While disposed to look favourably on the proposed scheme, the President and Council feel that no scheme of the kind would have much chance of success unless there were a general readiness on the part of civilized nations seriously to entertain the question.

I have, &c.,

G. G. STOKES, Secretary R. S.

To Edward Wingfield, Esq., Asst. Under-Sec. of State for the Colonies.

MEMORANDUM BY DR. DANIEL WILSON, PRESIDENT OF THE CANADIAN INSTITUTE, FOR TRANSMISSION WITH THE SECOND ISSUE OF MR. SANDFORD FLEMING'S PAPERS, BY HIS EXCELLENCY THE GOVERNOR-GENERAL TO THE IMPERIAL GOVERNMENT, APRIL 5TH, 1880.

Although the subject discussed in the accompanying papers has not hitherto attracted general attention, it has to some extent met with consideration in various quarters, and it is probable that at no distant day public interest will be awakened to its importance.

Uniform time has long been employed for scientific purposes; it has been used in recording simultaneous magnetic observations, in geographical and astronomical calculations, in observing the movement of tides, the track of meteors, the waves of earthquakes, and in systematically recording meteorological phenomena.

It is only of late years that the rapidity of communications by Railway, and the facilities afforded by the Telegraph, have created new conditions which suggest and seem to demand some general system of uniformity in reckoning Time in the ordinary occupations of life.

Those whose avocations bring them in contact with the inconveniences and complications which arise from our present notation, feel that the necessity of some improvement will before long become absolute.

The question is recognized to be cosmopolitan in its character; and although everywhere the difficulty may in some degree be felt, it is on the American Continent, in Canada and the United States, that it is rapidly gaining marked prominence.

A large amount of capital has been expended by the Dominion of Canada in the establishment of railways and telegraph lines, and the Government is now appropriating one hundred millions of dollars towards their construction to the Pacific Ocean.

In a few years the railways proposed will be completed, and they will extend over 75 degrees of longitude. The various clocks in the intervening distances, by which the lines will be operated, and the ordinary business of daily life carried on, will, under the present system of reckoning Time, differ from point to point, until the maximum difference of about five hours is reached. Accordingly the geographical extent of territory, and the general advancement of the Dominion of Canada, point to the necessity, at no remote period, of seeking for some change in the present system of reckoning Time.

The territory of the United States of America extends from Eastport in Maine to the western confines of Alaska, localities differing in longitude 100 degrees; in time, 6 hours and 40 minutes. Between

Maine and the Pacific States of Washington, Oregon and California, the difference in time is nearly 4 hours. The railway system is developing in a marvellous manner in the United States; the population is ten times that of Canada. If, therefore, the question of Time-reckoning claims attention in the Dominion, the necessity of its earnest consideration in the United States is still more manifest.

The American Metrological Society has had the subject under consideration. A careful report has been prepared, setting forth the necessity for change, and advocating uniformity and accuracy in the system of time-reckoning. From this report it appears that there are no less than seventy-five distinct local time Standards used by the Railways of the country, all differing the one from the other, the greatest difference reaching 3 hours and 58 minutes. The most prominent Railway managers have been consulted, and with the exception of a small minority, they have placed on record the opinion that "a uniform Time" would not only be a great convenience to the public and to the Railway employees, but would materially lessen the risk of accidents. It is accordingly strongly recommended that some means be taken to establish an absolute uniformity of Time throughout North America.

Mr. Sandford Fleming, by whom the Intercolonial Railway of Canada was constructed, and who is now Engineer-in-Chief of the railway in process of construction to the Pacific, has had his attention directed to the inconveniences, confusion, and complications in Time-reckoning which are threatened by the rapid extension of the railway works under his charge, and he has suggested a practical solution of the difficulties which he foresees.

The question is likewise of general scientific interest; and its solution is of value far beyond Canada, for it involves a question in which all civilized peoples are concerned. If uniformity be desirable in Canada and the United States, may it not be equally important to employ it throughout the whole world? Does it not therefore become desirable to seek the co-operation of men of science in other countries, and, if possible, gain general concurrence in any scheme which may be proposed?

At the instance of His Excellency the Governor-General of Canada, the subject was brought under the notice of the Royal Society of England. That distinguished scientific body has recently forwarded a communication to His Excellency, of which the following is an extract:—

"The President and Council of the Royal Society have taken into "consideration the proposals of Mr. Sandford Fleming, relative to "Time-reckoning and to the establishment of a Prime Meridian, "which were forwarded by the Council of the Canadian Institute, "with a memorial to His Excellency the Governor-General of "Canada.

"The proposal consists of two parts. (1) The establishment of a "system of Cosmopolitan Time, with plans for the ready passage "from this to approximate local Time. (2) The choice of a Prime "Meridian which should be common to all nations.

"The convenience of a system of Time-reckoning, which should be "common to all the earth, is easily seen, while at the same time it is "obvious that if such a reckoning be at all generally used, there must "be means of readily passing from it to local Time, or at least "approximate local Time, which is intimately bound up with the "daily business of life. The means recommended by the author are "simple and seem well devised. The difficulty is of course to induce "the different civilized nations of the world to concur in this, or any "similar scheme.

"With regard to the second point, the establishment of a Prime "Meridian, common to all nations, the author has adduced strong "reasons, founded on convenience, why a Meridian passing through "Behring Strait, or nearly so, should be chosen. It happens that a "Meridian 180° from that of Greenwich fulfils this condition, and if "this were adopted, the change in existing maps, etc., which refer to "the Meridian of Greenwich as the Prime Meridian, would not be "very serious.

"The choice, however, of a Prime Meridian, even to the extent of "adopting one exactly 180° from a Meridian at present in use, as a "Prime Meridian, is one upon which the susceptibilities of individual "nations might make it more difficult to obtain concurrence, than "upon the mere adoption of a common system of cosmopolitan time "reckoning in the abstract.

"While disposed to look favourably on the proposed scheme, the "President and Council feel that no scheme of the kind would have "much chance of success, unless there were a general readiness on "the part of civilized nations seriously to entertain the question."

Thus the report of the Royal Society recognizes the advantages derivable from a system of Cosmopolitan Time as an abstract proposition. The Metrological Society (New York) points out the positive urgency of reform in the United States, advocates that the use of local time be discontinued, and strongly recommends the adoption of a uniform Standard throughout the country. In Canada, as in the United States, the question has become one of practical economy. Even now the necessity for some more convenient system of reckoning Time is experienced, and on the completion of the railway to the Pacific Coast, the necessity will become absolute. It is, therefore, not only in the interest of North America, but as a question involving practical results of value to every civilized nation, that savants of other countries may be consulted with the view of maturing a scheme in every respect acceptable.

In pursuance of the suggestion implied in the report of the President and Council of the Royal Society, it appears advisable that an effort be made to ascertain how far the scheme would obtain general concurrence.

The establishment of Cosmopolitan Time involves the primary determination of an initial Meridian, as a zero for computing the revolutions of the globe on its axis; and it is only by common consent that such Prime Meridian can be determined.

Mr. Sandford Fleming advocates the selection of a Prime Meridian, common to all nations, from the fact that its establishment is really the key to any scheme of Time-reckoning, of universal application. He has submitted his views free from all local bias, and has aimed at the selection of an initial Meridian and Time-zero which, while awakening no national susceptibilities, would be generally acceptable to all civilized people.

It is earnestly hoped that this attempt to deal with an acknowledged impediment, alike to International scientific operations, and to the rapidly extending relations of trade and commerce, will be considered in a liberal spirit; and that civilized nations may be found not unwilling to concur in a proposal which offers a ready means of bringing into use some scientific system of reckoning Time such as the age seems to demand.

DANIEL WILSON, LL. D., F. R. S. E.,
President Canadian Institute.

TORONTO, April 5th, 1880.

NOTE FROM HIS EXCELLENCY THE GOVERNOR-GENERAL OF CANADA, TRANSMITTING MR. SANDFORD FLEMING'S PAPERS TOGETHER WITH THE REPORT OF THE AMERICAN METROLOGICAL SOCIETY, TO VARIOUS SCIENTIFIC SOCIETIES IN EUROPE.

GOVERNMENT HOUSE, OTTAWA, CANADA, May 12th, 1880.

The subject of a Prime Meridian common to all nations in connection with Time-reckoning having been brought to the notice of the Governor-General of Canada by a memorial from the Canadian Institute, the accompanying papers by Mr. Sandford Fleming are forwarded with His Excellency's compliments, together with a report of the American Metrological Society on the same subjects.

The Governor-General of Canada would be glad of any expression of opinion as to concurrence with the views therein stated which your

Society might desire to be conveyed to the Canadian Institute, under whose authority these papers have been published.

SOCIETIES IN EUROPE.

1.	The Institut de France	Paris.
2.	Société de Géographie	Paris.
3.	Société Belge de Géographie	Brussels.
4.	Königliché de Preussische Akademie der Wissenchaften	Berlin.
5.	Gesellschaft für Erdkunde	Berlin.
6.	Kaiserliche Akademie der Wissenchaften	Vienna.
7.	K. K. Geographische Gesellschaft	Vienna.
8.	Nicolaevskaia Glavania Observatoria	Pulkova.
9.	Imper. Rousskae Geograticheskoe Obschestov	St. Petersburg.
10.	Imper. Akademia Nauk	St. Petersburg.
11.	Société de Géographie	Geneva.

THE SECRETARY OF THE IMPERIAL ACADEMY OF SCIENCES, ST. PETERSBURG, TO THE GOVERNOR-GENERAL, CANADA.

ST. PETERSBOURG, le 10 Novembre, 29 Octobre, 1880.

MONSIEUR,—L'Académie Impériale des Sciences, ayant reçu, de votre part, les deux écrits de M. Sandford Fleming et Cleveland Abbe, sur l'adoption d'un Temps Universel et sur le choix, à cet effet, d'un Premier Méridien, a chargé M. Struve, Directeur de l'Observatoire Astronomique de Poulkova, d'examiner cette question.

Après avoir pris connaissance de ces ouvrages, M. Struve en a fait l'object d'un rapport qui était présenté à l'Académie dans sa séance du 14–26 octobre, 1880.

Conformément à la décision de l'Académie, j'ai l'honneur de vous transmettre ci-joints le rapport de M. Struve, ainsi que les deux exemplaires d'un discours en langue russe fait par lui en 1870, à la Société Géographique de St. Pétersbourg sur la même question.

Veuillez agréer, Monsieur, l'assurance de ma considération la plus distinguée.

C. VESSELOFSKY,
Sécretaire Perpétuel.

A Monsieur le Gouverneur-Général du Canada.

(TRANSLATION)

REPORT ON UNIVERSAL TIME AND ON THE CHOICE FOR THAT PURPOSE OF A PRIME MERIDIAN; MADE TO THE IMPERIAL ACADEMY OF SCIENCES, ST. PETERSBURG, BY M. OTTO STRUVE, MEMBER OF THE ACADEMY AND DIRECTOR OF THE OBSERVATORY AT PULKOVA.

[Read 30th September, 1880.]

The two papers (Sandford Fleming, "Time-Reckoning and the selection of a Prime Meridian," and Cleveland Abbe, "Standard Time, Report to the American Metrological Society,") sent to the Academy by order of the English Government, owe their origin to the great necessity felt in the United States and in the English possessions in North America for introducing into some branches of the public service, namely, the railway and telegraph departments, an uniform and rational system of time-reckoning. In the report of Mr. Abbe the problem is considered principally from a local point of view. He sets forth the motives that have engaged the American Metrological Society to adopt a series of resolutions with the view of lessening the defects in the system at present in use in the United States, a system which has been introduced, little by little, so to speak, without recognizing the wants of the traveller or the management of railways. There is, in this paper, but one resolution of a more extended range, that of recommending to the Government and the public, the exclusive use in the United States, of Time corresponding with the Meridian situated six hours to the west of Greenwich. The Metrological Society admits in principle the desirability in the future that an uniform Time should be introduced over all the globe, and it pronounces itself in favour of the Time reckoned from the Meridian, situated 180° from that of Greenwich.

The memoir by Mr. Fleming, supported in his conclusions by the Canadian Institute of Toronto, is of a more general character. It proposes directly the adoption of the Meridian, situated at 180° from Greenwich, as Prime Meridian for the whole globe, and the introduction of a Standard Time, reckoned from this Meridian, for the use of science and for certain purposes for use also in every-day life. This Time might be called Cosmopolitan Time to distinguish it from local Time, and his memoir presents different propositions in view of facilitating its general introduction. Nevertheless the arguments in favour of its universal introduction are merely stated in the said memoir as suggestions which may attract the attention of the world on this important question and lead to ulterior discussions. For the moment the author of this paper desires only to get from competent au-

thorities of different countries a response to the two following questions :—

1st. Does the Time zero, or Prime Meridian, proposed in the memoir, appear suitable and of a nature to be adopted by all civilized nations?

2nd. If the Prime Meridian proposed give rise to serious objections, would there be any other Meridian better qualified, and which would have more chance of being adopted by all the world?

Particular circumstances have singularly enabled the writer of this report to offer an answer to the first of these questions. Nearly ten years ago, at the desire of our illustrious President, the question of a Prime Meridian was made my special study; the results of which were given in a discourse, delivered on the 4th February, 1870, at the Geographical Society of Russia. On this occasion I discussed the question solely from a geographical point of view, specially considering the interests of hydrography and navigation.

On this point the simplest solution seemed to me to adopt as Prime Meridian that of Greenwich, which in this case would unite the majority of voices. The preference given to this Meridian was based, on one side, on the historical right of the Royal Observatory of England, acquired by eminent services rendered by this establishment during the course of two centuries to mathematical geography and navigation, on the other hand, considering that the great majority of charts now in use upon all the seas are made according to this Meridian, and about 90 per cent. of the navigators of long-standing are accustomed to take their longitudes from this Meridian. However, an objection against this proposition is that the Meridian of Greenwich passes through two countries of Europe, and thus the longitudes would be reckoned by different signs in different portions of our own continent, and also of Africa. Moreover, the close proximity of the Meridian of Paris, to which, perhaps, some French geographers and navigators of other nations would still hold, from custom, from a spirit of contradiction or from national rivalry, and which might easily cause sad disasters. To obviate these inconveniences I have proposed to choose as Prime Meridian another Meridian situated at an integral number of hours east or west of Greenwich, and among the Meridians meeting this condition I have indicated in the first place the Meridian proposed to-day by scientific Americans as that which would combine the most favourable conditions for its adoption.

Thus the Meridian, situated 180° from Greenwich, presents the following advantages :—

1. It does not cross any continent but the eastern extremity of the North of Asia, inhabited by people very few in number, and little civilized, called Tschouktschies.

2. It coincides exactly with that, where, after the custom introduced by an historical succession of maritime discoveries, the navigator makes a change of one unit in the date; a difference which is made near a number of small islands in the Pacific Ocean, discovered during the voyages made to the east and west. Thus the commencement of a new date would be identical with that of the hours of Cosmopolitan time.

3. It makes no change to the great majority of navigators and hydrographers except the very simple addition of 12 hours, or of 180° to all longitudes.

4. It does not involve any change in the calculations of the ephemerides most in use among navigators, viz., the English Nautical Almanac, except turning mid-day into midnight, and *vice versa*. In the American Nautical Almanac there would be no other change to introduce. With a cosmopolitan spirit, and in the just appreciation of a general want, the excellent ephemerides, published at Washington, record all data useful to navigators, calculated from the Meridian of Greenwich.

For universal adoption, as proposed by the Canadian Institute, it recommends itself to the inhabitants of all civilized countries, by reason of the great difference in longitude, thus removing all the misunderstandings and uncertainties concerning the question as to whether in any case Cosmopolitan or Local Time was used.

In answer to the first question offered by the Institute at Toronto, I would therefore recommend the Academy to pronounce without hesitation in favour of the universal adoption of the meridian situated 180° from Greenwich as Prime Meridian of the globe.

Accepting this conclusion, the second question brought by the Canadian Institute has no further interest to us.

It remains for me to say a few words on other questions presented in the memoir of Mr. Fleming. He offers suggestions on several points which awaken a desire for further investigation. These suggestions seem very wise. The ideas concerning the introduction of a common Time in all countries probably will yet take time to ripen, and some propositions set forth by Mr. Fleming will meet perhaps with insurmountable difficulties in the habits and interests of several countries. To my mind, the most serious obstacle consists in the fact that there is no means of indicating Cosmopolitan Time in different parts of the world, while the rising and setting of the sun are the phenomena which, we know, regulate the every-day occupations of human life. But the question presents itself in another way, when it affects only the sciences. Without doubt in some sciences, for example, astronomy, meteorology, physical geography, and generally in all questions requiring an exact determination of time,

the adoption universally of one Time would be a valuable advantage and might be easily effected. It would save much time and remove a number of difficulties. We must, however, own that in other scientific questions the usage of a local time in reference to the rising and setting of the sun would be preferable. For the present it would be well to consider at what point the introduction of Cosmopolitan Time in the sciences would be opportune.

The universal acceptance of another idea set forth by Mr. Fleming would probably meet with few obstacles, and its general introduction is recommended. In the opening pages of his memoir he makes the following remarks:—

> "The division of the day into two halves, each containing 12 "hours, is a fertile source of error and inconvenience. This "division has been long in use, but apart from its antiquity "there is nothing to recommend it, and its use does not confer "any benefit to man."

Permit me to say that I partake entirely of his views. For this reason I wish particularly to draw the attention of the Academy to them.

The division of the day into two halves seems to have slipped into common use without any sufficient reason. In consequence of the inconveniences it causes it is desirable that it should be replaced by the simple division of the day into 24 hours. The example of the Italians and some other nations, where this simple division is adhered to until this century, proves that its general adoption would not meet with serious difficulties.

To my idea the Academy would render a great service to the world if it supported this proposed change.

In conclusion, I take the liberty of sending, on the part of the Academy, two Russian papers read at the Geographical Society of Russia in 1870, which might be of interest to the Canadian Institute at Toronto, and to the American Metrological Society at Washington.

OTTO STRUVE.

30 September, 1880.

REMARKS ON A UNIVERSAL PRIME MERIDIAN, BY DON JUAN PASTORIN, LIEUT.-COMMANDER OF THE SPANISH NAVY.

Transmitted by the British Minister at Madrid through the Colonial Office by despatch, 13th March, 1882, to His Excellency the Governor-General. The communication is in the form of a preface to a translation and re-publication in the Spanish language, at the office of "Revista-General de Marina," of the several papers on Time-reckoning and a common Prime Meridian, published by the Canadian Institute (Toronto).

(TRANSLATION.)

It has always seemed to me very lamentable that there should exist such a multiplicity of Meridians, and, while in the classes of the Naval College I could not understand why the unscientific plurality of our reckonings of longitude, condemned openly by both the Professors and the books we studied, should be persisted in. Spain has counted the longitude from the Meridian of the Straits of Gibraltar, Toledo, the ancient College of Santo Guardo de Cadiz, San Fernando (in two different citations those of the two observatories, the ancient one and the present one), Ferrol, Cartagena, Plaza Mayor of Madrid, observatory of the same capital, Coimbra, Lisbon (in three distinct places corresponding to the successive observatories), the Cathedral of Manilla, the Island of Hierro (in different points, some doubtful)—and, to-day, it is proposed heedlessly to give another Meridian of reference.

The marine authorities of the most advanced countries of the world count the time by Greenwich, Paris, San Fernando, Naples, Christiania, Island of Hierro, Pulkova, Stockholm, Lisbon, Copenhagen, Rio de Janeiro; and I do not cite Washington because the authorities of the great Republic of North America, setting aside small ideas and national jealousy, use for the purposes of navigation the time of Greenwich.

It is therefore a natural consequence that the geographer in examining different charts and in reducing one Meridian to another, finds himself surrounded with difficulties, and in some cases impossibilities, for the reduction is impracticable on maps not arranged upon the Mercator projection.

Why should there be this intolerable multiplicity?

Several times it has been attempted to do away with it, but without success. In 1869, Spain appointed a Commission to propose rules respecting our maps and charts; but notwithstanding the competency of the individuals who composed it,* the Commission ceased its labours without even giving a reason why nothing had been done.

International Congresses have met in Antwerp and in Paris, but have not come to any decision respecting geographical maps; nor are

* The Commission was composed of José Emilio de Santos, Francisco de Paula Marquez, Francisco Chacon y Orta, Antonio Aquilary Vela, Carlos Ibanez, Eduardo Benot and Jose Morer.

there any signs of any attention being paid to the resolution adopted in Antwerp, where it was agreed that in maritime charts the Meridian of Greenwich should be used. Custom so enslaves common sense that we admit as natural, things which are most ridiculous, and we are not even prompted to smile at the absurdity. Thus here in Madrid we receive telegraphic despatches from the Philipine Islands hours, and sometimes even the day previous to that on which the events referred to therein have taken place. The same happens in England respecting the despatches from Australia. I remember an example in point; at three in the morning of the 1st October, 1880, they received in London the news of the opening of the Universal Exhibition at Melbourne at one o'clock in the afternoon of that day.

What argument is advanced for the continuation of a state of things which becomes more and more indefensible?

I confess I have never seen one plausible reason given for the present system.

Antiquity is the claim made by those who favor the Meridian of Teneriffe and Hierro.

The security of direct observation is the boast of the partisans of each Meridian held by their particular observatory.

The division of the continents into two hemispheres is advocated by those whose sympathies are with the same Meridian of Hierro, or with the Meridians contiguous to Behring Strait, as the initial circle would result in being anti-meridians of Greenwich, Christiania, Naples and Paris.

The great Laplace has said: "It is desirable that all the nations of Europe, in place of arranging geographical longitude from their own observatories, should agree to compute it from the same Meridian, one indicated by nature herself, in order to determine it for all time to come. Such an arrangement would introduce into the science of geography the same uniformity which is already enjoyed in the calendar and the arithmetic, and, extended to the numerous objects of their mutual relations, would make of the diverse peoples one family only."

The disadvantages and confusion resulting from the multiplicity of the zeros of longitude, are so great that the whole world ought to proclaim the necessity of one universal Meridian, but still there are those who do not seem to recognize it. There are others who oppose the adoption of an international Meridian on the ground of the difficulty of determining with absolute precision the difference of longitude between two places, although situated on the same continent, and in support of their arguments they cite the discrepancies in the results of modern observatories as compared with ancient ones, although the former are made from observatories so favourably situated as those of Paris, Greenwich, Washington, &c.

Not being satisfied with the arguments against a universal Meridian, it can be imagined my surprise when it came to my knowledge that a body of men so distinguished and competent as the Geographical Society of Madrid had recommended another Meridian passing by the Punta de la Orchilla, the extreme western end of the Island of Hierro. One more Meridian, when there were so many already!

Desirous of understanding the reasons which prompted the Society to adopt such a resolution, I solicited the honour of being allowed to enter into the subject. This was conceded to me, and while it was occupying my mind I came into possession of the very valuable documents given to the light by the Canadian Institute, and which are the offspring of the clear intelligence of one of its most distinguished members, Mr. Sandford Fleming.

So thoroughly was I convinced by the arguments of this eminent engineer, and so very practical did his system seem for the creation of a uniform Time-reckoning for the whole world, that I resolved to translate his valuable paper into our language, with the view of founding upon it a proposition which I should ere this have presented to the Geographical Society had not my time been wholly taken up by a Special Commission entrusted to me by His Excellency the Minister of Marine, Don Santiago, Duran of Lira, in connexion with the constant differences which take place between our fishermen and those of Portugal on our southern coasts.

The work which follows this preface is not, strictly speaking, a literal translation of the paper of the distinguished member of the Canadian Institute, but I believe, nevertheless, that I have most faithfully interpreted the thoughts of the wise academician, and also faithfully presented the essential passages of his work. If I have not done so, it has not been the fault of my good will.

Will the ideas of the author ever be adopted and put into practice? For my part, I think they will. The present system is indefensible, and it is only necessary to study the new method without prejudice, and think over the means proposed, to see their clearness.

Will there be found people to find fault with the system?

Undoubtedly! The electric telegraph was considered an impossibility half a century ago, and, to-day, the wires of this impossibility encircle our globe.

JUAN PASTORIN.

Ayamonte, 30th April, 1881.

THE GEOGRAPHICAL SOCIETY OF BERLIN, 1881.

*Remarks upon a Normal Time to be common to the whole earth, and a Prime Meridian, to be accepted by all nations, by Dr. G. V. Boguslawski.**

(TRANSLATION.)

During the last decade, the gigantic development of railway and telegraph communication in the United States and the British possessions of North America, has in a marked manner caused the necessity to be felt of a common recognized system of Time-reckoning throughout this extensive territory. As a result of this feeling, in the course of this year, two publications have appeared which, with a view to the solution of this problem, submit projects of some force not adaptable to America alone, but which to some extent would be acceptable to the whole world, namely: Cleveland Abbe, "Report on Standard Time to the American Metrological Society," and Sandford Fleming, "Papers on Time-Reckoning and the selection of a Prime Meridian to be common to all nations."

The Director of the Observatory at Pulkova, member of the Academy of Science, St. Petersburg, and our honorary member, Herr Otto Struve, in accordance with a commission of this Academy in the meeting of September, 1880, has presented a report on both these papers, and on the propositions which they contain for the solution of the general question of a normal Time-reckoning and of a universally observed first meridian, which, in connection with other remarks on the same question, we will allude to.

The report of Mr. Cleveland Abbe chiefly examines the problem from a local point of view. He sets forth the motives which have prevailed with the American Metrological Society, to accept a series of resolutions which, from the imperfections in the present system followed in the United States of America, have in view the removal of the inconveniences proceeding from present practice of Time-reckoning, a practice which, so to say by degrees and incidentally, has come into force, without taking any account of the necessities of the travelling public and the management of railways. One resolution only in the dissertation of Cleveland Abbe, is of a more wide-bearing significance, viz., that which recommends to the government and to the public within the United States to refer the Time exclusively to a meridian 6 hours or 90° west of Greenwich. The Metrological Society thus accepts the principle that it is desirable that in the future a uniform central Time be introduced for the whole earth, and by this opportunity expresses itself in favour of the meridian 180° from Greenwich as the first meridian.

* Verhandlungen der Gesellschaft für Erdkunde, zu Berlin. Herausgegeben im Auftrage des Vorstandes von Dr. G. V. Boguslawski. Band VIII., No. 6 u. 7. Zeitungen von 9 Juni und 2 Juli, 1881, Berlin.

The dissertation of Mr. Sandford Fleming is of a more extended (*allgemeineren*) character, and his propositions founded upon it, were sustained by the approval of the Canadian Institute, at Toronto, and it is this body, by the intervention of the British Government, which has more widely circulated Fleming's paper. Fleming directly advocates the acceptance of the meridian 180° from Greenwich as the first meredian for the whole earth, and the universal establishment of time reckoned upon this meridian for scientific purposes, and even for many of the relations of every day life. This time we may distinguish as "Cosmopolitan Time," in distinction to local time.

Fleming submits in his treatise different arguments in favour of the universal introduction of this Cosmopolitan Time, indeed mostly in the form of more generally expressed ideas which direct attention to this weighty question, and which can serve as the starting point for a more extended discussion. Above all things, he is desirous of obtaining from competent professional men of all countries, definite answers to the following two questions:

1. Does the Time-zero or Prime Meridian, proposed in the memoir, appear suitable and of a nature to be adopted by all civilized nations?

2. If the Prime Meridian proposed give rise to serious objections would there be any other meridian better qualified, and which would have more chance of being adopted by all the world?

Special circumstances enable Herr Otto Struve to answer the first of these questions, since as early as the 4th February, 1870, before the Geographical Society of St. Petersburg, he discussed the questions in connection with the first meridian, and exclusively from the geographical point of view, with which he specially connected the interests of Cartography (map making and navigation). The simplest solution seemed to him to be to take as a first meridian, that of Greenwich.

Struve sustained this expressed preference on one side by the historical claim of the Observatory of Greenwich which it has established from two centuries of super-eminent service to the cause of mathematical geography and the interests of shipping, and on the other hand from the consideration that the greater part of the present maps in use, especially sea-charts, are projected relatively to this meridian of Greenwich, and that about ninety per cent. of seamen refer their longitudes to this meridian.

But, indeed, according to Otto Struve, there is the circumstance which declares itself against the common establishment of the meridian of Greenwich, as the first meridian, that it passes over three countries of Europe, Great Britain, France and Spain, likewise the continent of Africa, and that accordingly in different parts of Europe and Africa the longitudes would have different descriptions east or west

from Greenwich (or the signs + or —).* The first meridian proposed by Sandford Fleming, 180° from that of Greenwich, according to the present opinion of Otto Struve, offers the following points of pre-eminence:

1. "It passes through no continent excepting the eastern end of North Asia, which is inhabited only by a not numerous and uncivilized tribe, the Tschuktschen.

2. "It closely coincides with that same meridian upon which the seamen, according to custom, must change the date of a day.† The change of a day's date would accordingly coincide with that of the Cosmopolitan Meridian.

3. "It changes nothing in the practice of the majority of seamen and geographers, with the exception of the addition of 12 hours or 180° to all longitudes.

4. "It occasions no change in the calculation of the ephemerides in most general use by seamen, namely, those of the British Nautical Almanac, except the simple transfer of mid-day to mid-night or *vice versa*.

5. "The great differences which would exist between Cosmopolitan and Local Time by the acceptance of this first meridian by the inhabitants of almost all civilized lands would remove all misunderstandings and uncertainties, under different circumstances as to whether Cosmopolitan or Local was intended to be acted upon."

Upon these grounds Herr Otto Struve, of the Academy of Science of St. Petersburg, is willing to recommend for common acceptance the meridian 180° west of Greenwich as the first meridian.

By this opinion the second of Fleming's submitted questions obtains its solution.

With regard to the questions submitted by Mr. Fleming in the general form, as a starting point for further discussion on the introduction for all countries of a common Time-reckoning the Pulkova astronomer remarks, that at present from the various customs and interests of different countries, it must be received with hesitation.

* But it would be easy to remedy this inconvenience, if according to the example of Prof. A. Auwers, in whose praiseworthy contribution to the Geographical Year Book VIII. (1880, pp. 303-310), "Geographical Longitudes and Latitudes of 144 Observatories," all the longitudes from Greenwich are numbered easterly through the full circumference of the circle. Also Prof. C. Bruhns has in his report on Point 33 of the Programme of the Second Meteorological Congress at Rome, 1879, in which he proposes universally to accept the Meridian of Greenwich for Meteorological Maps, laid it down as indispensable, that by the acceptance of any first meridian whatsoever, the longitudes run in one direction only, and indeed be reckoned from the East. The computation in different directions easily leads to misunderstanding and furnishes cause for complications.

† On a ship which, from the East (America), sails to the West (Asia or Australia), and reckons its time according to the mean time of Greenwich, they count from the meridian 180° from Greenwich. If, for example, on 27th July, Greenwich is at mid-night, and then begins the date of the 28th July, it is no more than mid-day on the 27th July, and they must, in order to accord with the Greenwich date, then move forward its date one day from 27th to 28th. Another ship, which sails from the West (Asia or Australia) to the East (America), and equally reckons the time from Greenwich, if Greenwich on the 27th July is at no more than mid-day, upon the meridian 180° from Greenwich it is already mid-night of the 28th July, and they must, in order again to come in accord with the Greenwich date, put back its date a day, thus to count the same date twice over.

The greatest difficulty presents itself in the fact that as yet no means of bringing Cosmopolitan Time into certain relationship with the rise and setting of the sun in the different parts of the earth; the appearance of the sun admittedly governing the ordinary avocations of business life.

But if we consider this question in a scientific spirit, it follows that for some but not for all branches of sciences, for example, for Meteorology and Astronomy and in part also for physical questions of the earth, and in general for all questions which are affected by the close determination of time, the common acceptance of one and the same Time would extend great advantages, and could be effected with little difficulty. Besides, it would save much time, and set aside a great extent of misunderstanding.

According to Struve's view, we must in the first place investigate in what relationship the introduction of Cosmopolitan Time be opportune for science, and for what scientific problems the application of Local Time with its relationship to the rise and setting of the sun can be indicated.

The common acceptance of another proposition of Fleming's, according to Struve, should meet with slight objection, and is to be recommended, viz., to set aside that division of the day into two halves of 12 hours, brought down to us from antiquity, and in its place to establish the simple division of 24 hours, as at present is the case with the Italians;* so indeed that besides the standard datum, exact Standard Time for the several chief places, in the form of 24 Standards one hour apart should be established from which all the remaining Local Times would obtain their derivation.

Our associate, Prof. W. Förster, Director of the Observatory of this place, at the conclusion of his paper, "Review on some Time considerations, especially concerning the establishment of a German Standard Time," read at Hamburg, 7th February, 1881 (*Deutche Revue, 1881, No. 3 and 4*), has likewise taken into consideration this proposition of the Canadian Institute, and expresses himself against the introduction of 24 chief Local Times for ordinary life, in international relations. On the other hand, he accepts the introduction of a universal and not a national Standard Time in connection with a standard datum for all transactions requiring precision in time. The specified starting-point and time-determination yet to be established, named in the Canadian papers as the "Cosmopolitan," according to Prof. Förster's view, must be the common principle of a universally accepted and undisputed measure of time freed from all differences of local time. Equally for the starting point of Universal Time, he considers the meridian the best suited to be the one exactly 12 hours or 180° from that of Greenwich (thus precisely identical with that of Greenwich).

G. V. B.

* Also the day is divided by astronomers into 24 hours.

ADDRESS AT THE INTERNATIONAL GEOGRAPHICAL CONGRESS, VENICE, SEPTEMBER 21ST, 1881, ON THE REGULATION OF TIME AND THE ADOPTION OF A PRIME MERIDIAN.

By SANDFORD FLEMING, *Delegate, of the Canadian Institute, Toronto, and the American Metrological Society, New York.*

The subject to which, with your permission, I shall briefly refer, is the establishment of a Prime Meridian and Time-zero, to be common to all nations.

The history of geographical science informs us that a great number of initial meridians have at various times been employed by astronomers and navigators. It is well known that Claudius Ptolemy of Alexandria was among the first to fix a meridian of reference. Ptolemy lived in the second century, when the inhabitable world was thought to be limited to countries around, or not far beyond, the shores of the Mediterranean. From time to time a knowledge of the earth's surface extended, and distinguished geographers arose, who adopted new initial meridians. It is not necessary that I should trouble you with a recital of the list of meridians from which, since the earliest period, longitudes have been reckoned. It is sufficient at this stage to refer to the fact that geographers of different nations have generally selected for starting points places of importance well-known to them, and that, as a rule, they have chosen the capitals or the principal observatories of the nations to which they respectively belonged. Hence the multiplication of meridians of reference throughout the world. Within a comparatively recent period communications between the peoples of different nations have been greatly facilitated, and intercourse has proportionately increased. It has consequently been felt that the variety of first meridians is embarrassing and unnecessary. For a number of years the question of reducing this number has been under consideration; it has been brought before the Geographical Congress at Antwerp, and again at Paris. The question has been examined by different societies, and various proposals have been submitted, but unanimity with respect to the selection of a prime meridian to be common to all nations has in no way been attained. Repeated efforts have been made to gain general concurrence to the adoption of one of the existing national meridians, but these proposals have tended to retard a settlement of the question by awakening national sensibilities, and thus creating a barrier difficult to remove. Other proposals to select an entirely new initial line, unrelated to any one of the first meridians at present recognized, have but little advanced the settlement of the question, as such a course encounters difficulties of another kind, difficulties so serious in their character as to render the proposals almost impracticable.

There are reasons for a unification of first meridians which every year become stronger, and, as the question affects the whole area of

civilization, its consideration should be approached in a broad, liberal spirit. While it may be urged that the selection of any particular meridian is less important than the adoption of a common first meridian, care should be taken to consider the interests of all people concerned, or likely to be concerned, scrupulously avoiding offence to local prejudice or national vanity. On every account it is extremely desirable that an earnest effort should be made to seek for a solution to the problem.

The unifications of initial meridians has been advocated in the interests of geography, astronomy and navigation. I shall accept all the arguments which have been advanced on behalf of these extremely important interests, and crave your indulgence while I submit additional reasons for the establishment of a common prime meridian for all the world.

I propose to direct your attention to arguments which spring from the relations of time and longitude and the rapidly growing necessity in this age for reform in time-reckoning.

If we take into view the whole earth, we have at the same instant in absolute time, noon, mid-night, sun-rise, sun-set, and all intermediate gradations of the day. The telegraph-system, which is gradually spreading like a spider's web over the surface of the globe, is practically bringing this view of the sphere before all civilized communities. It leaves no interval of time between widely separated places proportionate to their distances apart. It brings points remote from one another, enjoying all the different hours of daylight and darkness, into very close contact. Under our present system of notation, confusion is developed, and all count of time is thrown into disorder.

The local civil day begins twelve hours before and ends twelve hours after the sun passes the meridian of a place. As the globe is constantly revolving on its axis, a fresh meridian is every moment coming under the sun. As a consequence, a day is always beginning somewhere and always ending somewhere. Each spot around the circumference of the sphere has its own day, and therefore there are during every diurnal revolution of the earth, an infinite number of local days, all beginning with a space of twenty-four hours, and each continuing twenty-four hours. These days overlap each other, and, theoretically, they are as perfectly distinct as they are infinite in number. There are no simultaneous days except on the same meridian, and as the different days are always in the various stages of advancement, difficulties must necessarily result in assigning the period when an event takes place. The telegraph may give the exact local time of the occurrence, but it will be in disagreement with the local times on every other meridian around the earth. An event occurring any one day may on the instant be announced somewhere the previous day, or somewhere else the following day. About the

period when one month or year passes into another month or year, an occurrence may actually take place in two different months, or in two different years, according to local reckoning.

It will be readily conceded that this system is extremely unscientific, that it possesses all the elements of confusion, and produces a degree of ambiguity which cannot long be tolerated, that as time rolls on, it will lead to grave complications in social and commercial affairs, that it will produce serious errors in chronology, that it will lead to litigation, and result generally in difficulties of various kinds. According to our present system there can be no absolute certainty with regard to time unless the precise geographical position be specified as an important element of the date. It is evident that it will be exceedingly inconvenient and troublesome when rapid intercourse becomes universal to bring the times of different countries and localities into agreement; and that the necessity for doing so by additions or deductions for differences in longitude, will undoubtedly clog the ordinary business of the world.

It is proposed to obviate the difficulty by a system of cosmopolitan time-reckoning, the chief peculiarity of which is the adoption of one particular meridian as a standard time-zero, and by an extremely simple arrangement regulating the times at all places on the globe by a direct reference to the common standard. It is obvious that the world's time zero should coincide with the prime meridian to be used in common by all nations for reckoning terrestial longitudes.

I shall proceed to submit special and more urgent reasons for the selection of a common initial Meridian and Time-zero. I shall confine my observations to the case of North America, a country with which I am most familiar, but the remarks I shall venture to submit will doubtless apply to other great divisions of the earth's surface.

The gigantic system of railways and telegraphs which has been established in America, has developed social and commercial conditions which never previously existed in the history of the human race. These conditions have affected the relations of time and distance in a manner which shows that the system of notation which we have inherited is defective, that it leads to confusion, causes loss of time, and disturbs the arrangements of travellers and business men, that it frequently results in loss of life, and leads to difficulties of various kinds, that under the circumstances which have followed the extensive employment of steam and electricity as means of rapid communication, it is generally inappropriate.

This question has therefore become a matter of great public importance, and attention is seriously directed to the simplest and best means of removing an impediment to commerce and general intercourse.

The system which we follow, and which has been followed for ages, was quite unobjectionable half a century ago, when the electric tele-

graph was unknown and the horse was almost the only locomotive. The system is based on the theory that time is regulated everywhere by the passage of the sun over the meridian of each separate locality, that the period between any two solar passages, at any one place, is divided into halves, known as *ante-meridian* and *post-meridian*, each half being subdivided into twelve hours, and that the two halves together constitute a day.

According to the recognised theory, as already stated, every spot on the surface of the globe differing in longitude has an entirely distinct day, and a local time peculiar to itself. Except on the same meridian there are no simultaneous days, or hours or minutes. Everywhere the days and divisions of the day vary, and the variations are infinite.

In the case of North America the continent extends across one hundred and five degrees of longitude. Within its extreme eastern and western limits it is possible to draw many thousand distinct meridians, and following rigidly the prescribed theory, we may have as many thousand standards of time, not two of which would be in harmony. The railway authorities have come face to face with the difficulty, and they have from time to time met it as circumstances dictated. In order to operate the long line of railway with some degree of safety, each separate manager has been obliged to ignore the different local times and arbitrarily adopt a special time for the movement of trains on the particular lines under his charge. The railway guide books publish at least seventy-five (75) irregularly chosen standards of time, employed for the running of trains in the United States and Canada. Every city and town of importance has its own time, occasionally coinciding, but frequently differing from the nearest railway standard. The public have been obliged to accommodate themselves to this irregular system, but it has become exceedingly inconvenient and irksome, and a scheme which will introduce a time-system characterized by uniformity and simplicity cannot fail to be cordially welcomed.

For the reasons stated, an earnest movement has begun in America with the view of establishing reform in time-reckoning. The question is engaging the attention of the Canadian Institute, the American Metrological Society, the American Society of Civil Engineers, the American Association for the Advancement of Science, and other Societies. The community generally and the great railway and telegraph interests are being awakened to its importance.

It is felt that the question is one in which all countries have an interest, and although it has presented itself perhaps more prominently in America than elsewhere, it is eminently desirable that Americans should take no narrow view of a scientific matter of world-wide interest.

It is held by those who have seriously considered the subject, that a solution of the problem which would be good for America would be advantageous for other countries. It is considered that in introducing a reform in time-reckoning in North America the system should be such as would commend itself generally; that it should be one which by its appropriateness and simplicity would have every prospect of being adopted ultimately throughout the world.

A highly important feature of the movement is to employ every means to render the system generally acceptable, so that whenever the necessity may arise in any other community for its introduction it may be spontaneously adopted—a course calculated to secure ultimately complete uniformity in all countries.

I shall give in brief an outline of a proposition for defining and regulating civil time which is favoured in many quarters in Canada and the United States of America:—

1. It is proposed to establish one standard time which may be common to all people throughout the world, for communication by land and sea, for all ordinary purposes, for synchronous observations, and for all scientific purposes. This standard time to be known as *Cosmopolitan Time.**

2. Cosmopolitan Time to be based on the diurnal revolutions of the earth as determined by the (mean) sun's passage over one particular meridian to be selected as a Time zero.

3. The Time-zero to coincide with the Prime Meridian to be common to all nations for computing longitude.

4. The Time-zero and Prime Meridian for the world to be established with the concurrence of civilized nations generally.

5. Twenty-four secondary or standard Hour-meridians to be established, fifteen degrees or one hour distant from each other, the first being fifteen degrees from the Prime Meridian.

6. The standard Hour-meridians to regulate time at all places on the earth's surface.

7. The twenty-four standard Meridians to be denoted by symbols, and, preferably, by the letters of the English alphabet, which, omitting J and V, are twenty-four in number. The letters to be taken in their order from east to west. The Zero-meridian being lettered Z.

8. The hour of the day at any place on the earth's surface to be regulated by some one of the standard Meridians, generally by the standard nearest such place in longitude.

9. It is proposed to distinguish that interval of time between two consecutive passages of the (mean) sun over the Prime Meridian by the term *Cosmopolitan Day.*

10. The Cosmopolitan Day is designed to promote exactness in chronology, and is intended to be employed in connection

* The term "Cosmic" since suggested, commends itself.

with synchronous observations in all parts of the world, and for scientific purposes generally.

11. Local days to commence twelve hours before, and end twelve hours after the (mean) sun's passage over each of the standard Meridians. The local days to be distinguished by the letters of the twenty-four Meridians which determine them.

12. Local days will be reduced to twenty-four in number within the period of each diurnal revolution of the earth. They are to be regarded in the same light in all ordinary affairs as local days under the present system.

13. The hours of the *Cosmopolitan Day* to be known by the letters of the alphabet in their order from A to Z (omitting J and V), corresponding with the twenty-four Hour-meridians. When the (mean) sun passes Meridians G or N, it will be G time or N time of the *Cosmopolitan Day*.

14. It is proposed to abandon the divisions of the local day into two sets of hours, each numbered from one to twelve, and to employ a single series numbered from one to twenty-four without interruption; or as an alternative plan, to number the twelve hours from midnight to noon, as at present, and to letter the hours from noon to midnight. The afternoon letters being in agreement with the proper Cosmopolitan Time letters.

15. The time determined directly from the Prime Meridian, as in the Cosmopolitan Day, to be known by the general term *Cosmopolitan Time*.

16. Local time to be known by the particular standard Meridian to which it is referred. If it be determined by Meridian B it will be designated *Standard B Time*.

17. It is proposed to have standard time determined and disseminated under Governmental authority.

18. Each city and town of importance to have a public time-signal station electrically connected with a central observatory for the purpose of receiving and disseminating standard time with precision.

19. Each time signal station to be provided with automatical apparatus for dropping time-balls, or otherwise denoting the standard time hourly, or as often as circumstances may require.

20. All railway and local public clocks to be controlled electrically from the public time-signal stations.

The foregoing is a general outline of the proposition. It must be evident that the system of Cosmopolitan time would be a ready means of meeting the difficulties to which I have referred. It would render it practicable to secure uniformity, great simplicity, perfect accuracy, and complete harmony. The times of places widely differ-

ing in longitude would differ only by entire hours. In all other respects Standard time in every longitude and latitude would be in perfect agreement. In theory every clock in the world would indicate some one of the twenty-four hours at the same instant, and there would be perfect sychronism with the minutes and seconds everywhere around the globe.

By the system proposed, instead of an infinite and confusing number of local days following the sun during each diurnal revolution of the earth, we should have twenty-four well defined local days only; each local day would have a fixed relation to the others, and all would be governed by the position of the sun in respect to the Prime Meridian. These twenty-four local days would succeed each other at intervals of one hour during each successive diurnal revolution of the globe. The day of each locality would be known by the letter or other designation of its standard Meridian, and the general confusion and ambiguity which I have set forth as the consequences of the present system would cease to exist.

Some such system as that proposed is imperatively demanded in America. It cannot be doubted that the general adoption of the scheme portrayed would be conducive to the convenience of all mankind. The first step towards its introduction is the selection of an initial Meridian for the world. Accordingly I feel justified in asking you to favourably consider the resolutions which I have now the honour to submit.

RESOLUTIONS.

Resolved—1. That the unification of initial Meridians of reference for computing longitude is of great importance in the interests of geography and navigation.

Resolved—2. That the selection of a Zero-meridian for the world would greatly promote the cause of general uniformity and exactness in Time-reckoning.

Resolved—3. That in the interests of all mankind it is eminently desirable that civilized nations should come to an agreement with respect to the determination of a common Prime Meridian, and a system of universal Time-reckoning.

Resolved—4. That the Governments of different countries be appealed to immediately after the close of Congress, with the view of ascertaining if they would be disposed to assist in the matter by nominating persons to confer with each other and endeavour to reach a conclusion which they would recommend their respective Governments to adopt.

Resolved—5. That in view of the representations which have come to this Congress from America it is suggested that a Conference of Delegates who may be appointed by the different Governments be held in the City of Washington, and that the Conference open on the first Monday in May, 1882.

Resolved—6. That the gentlemen whose names follow be an Executive Committee to make arrangements for the proposed Meeting of Delegates, and to take such steps as may seem expedient in furtherance of the objects of these resolutions. And that all communications in respect thereof be transmitted to General W. B. Hazen, Meteorological Bureau, War Department, Washington.

DR. F. A. P. BARNARD, *President of American Metrological Society, New York.*

CAPTAIN GEORGE M. WHEELER, *Corps of Engineers, U. S. A., Washington.*

CHIEF JUSTICE DALY, *President of the American Geographical Society, New York.*

JUSTICE FIELD, *Supreme Court, Washington.*

GENERAL G. W. CULLUM, *Vice-President American Geographical Society, New York.*

GENERAL W. B. HAZEN, *Director of Meteorological Bureau, Washington.*

JUDGE PEABODY, *American Geographical Society, New York.*

PROFESSOR CLEVELAND ABBE, *Signal Office, Washington.*

DAVID DUDLEY FIELD, *American Geographical Society, New York.*

JAMES B. FRANCIS, *President of the American Society of Civil Engineers, Boston.*

DR. DANIEL WILSON, *President of Toronto University, Toronto.*

JOHN LANGTON, *President of the Canadian Institute, Toronto.*

SANDFORD FLEMING, *Chancellor of Queen's University of Canada, Kingston.*

Resolved—7. That the Italian Government be respectfully requested to communicate these resolutions to the Governments of all other countries.

After full discussion the Committee agreed to report favourably, and recorded the following minute :—

[TRANSLATION.]

The Committee considers that within a year an International Commission may be appointed by the Governments to consider the question of an Initial Meridian, having in view not only the question of longitude but specially that of hours and dates. The Commission should be composed of scientific men, such as geodicians, geographers and men who represent the interests of commerce, etc. Three members might be named by each nation. The President of the Italian Geographical Society is requested to take the initiative in bringing the subject before his Government and foreign Geographical Societies, and to take the necessary steps for the realization of the wish

expressed in the resolutions. Without deciding, the Committee desires to draw attention to the proposition of the American Delegates that the proposed International Commission should meet at Washington.

REMARKS ON THE COSMOPOLITAN SCHEME FOR REGULATING TIME.

By Professor Simon Newcomb, *Superintendent of Nautical Almanac, Washington, 1882.*

A capital plan for use during the millennium. Too perfect for the present state of humanity. See no more reason for considering Europe in the matter than for considering the inhabitants of the planet Mars.

No; we don't care for other nations, can't help them, and they can't help us.

PROCEEDINGS OF THE ITALIAN GEOGRAPHICAL SOCIETY.

Examination of the scheme of Time reform; from the work of M. Ferdinando Borsari, 1883.

(translation.)

Is Universal Time possible? *

The question of the choice of a Cosmopolitan Meridian being determined, it remains to be seen to what extent it may be possible to carry into effect in different countries the propositions of Mr. Sandford Fleming and of the other Americans interested in the introduction of the system of Cosmic Time and of twenty-four different systems of local Time, each in succession differing from the other by one hour.

The form given to this proposition, moreover, the very extraordinary clearness with which it has been set forth (see Part II.), is marked by much logic, so that a profitable and well-considered investigation of it may be held. Nevertheless, there is strong reason why we should not deceive ourselves as to the difficulties to be overcome. The idea relative to the introduction of the one Time in all countries will need a long period to popularize it in Europe, and to enter, so to say, into the convictions of the majority; and many of the propositions of Mr. Sandford Fleming (above all, that relative to local Time,) will perhaps encounter much insurmountable difficulty from the inhabitants of different countries, besides striking against several national traditions.

In our opinion, the most serious obstacle consists in the fact that there is no means in the different countries to bring Cosmopolitan

* Extracts from Il Meridiano Miziale e L'Ora Universale, Studio di Ferdinando Borsari Socio a vita della Società Geografica Italiana, Direttore della rassegna geografica a L'Esplorazione. Napoli, 1883. (Page 62.)

Time into accord with the rising and setting of the sun—phenomena which, as we say, necessarily regulate all the ordinary occupations of human life.

Besides, there is another fact which would confirm the necessity of maintaining the present national hours, in place of adopting the secondary Time proposed by Mr. Sandford Fleming, even should Cosmopolitan Time be universally adopted. It presents itself in this form :—At present the political boundary of the several States of Europe establishes the limit throughout which the recognized national date would cease to be used, *e. g.*, that of Rome, and at which commences the use throughout of the other national dates, *e. g.*, that of Paris, with regard to which nothing equivocal can take place. But supposing this national hour was suppressed and the secondary hour adopted, very many, with the exception of the astronomers, would not be gifted with the precise knowledge at what place the use of one date should cease and the other day of the secondary hour commence. In the hypothesis that the initial anti-meridian of Greenwich should be adopted, it would thence arise that a part of Spain would use the Meridian M, and the other the Meridian N; the dividing line would be the Meridian situate at 187½° of longitude (with the new system it would be no longer necessary to adjoin east or west, for longitude would be counted from east to west), and all the countries situated to the east of this line would use the Meridian M, and that of the west the Meridian N. But how in practice to obtain this separation? But admitting even that it be obtainable, would it be possible to have part of the same country (in Spain as in Switzerland, in Germany, &c.,) with a system of Time different to that used in another part. We do not believe this determination by hour possible, at least in political life.

But the question presents itself under another aspect when we speak only of scientific consideration. And without doubt in any science, as, for example, astronomy, meteorology, in part terrestrial physics, and generally in all scientific questions connected with the exact determination of time, the universal adoption of Cosmopolitan Time would be a precious advantage, and would be brought to pass without difficulty. It would save many useless calculations, much loss of time, and would remove much misconception. Moreover, equally, we must acknowledge, that in other scientific questions the use of local Time owing to its agreement with the phenomena of the rising and setting of the sun would be preferable.

Therefore at the present time we ought to recommend the adoption of Cosmopolitan Time in all the branches of science in which, without inconvenience, it can be introduced, with the possibility of extending it hereafter; moreover, in all public services in the departments bearing upon international relations.

The general adoption also of one of the propositions of Mr. Sandford Fleming, that relative to the enumeration of the hours of the day in a single series of 1 to 24, would probably encounter many obstacles; but its introduction should be advocated in all countries.

In fact, as we see, the division of the day into two halves, each of 12 hours, is a cause of numerous errors and inconveniences. This division has been for a long time in use. But undoubtedly apart from this reason no one can find any ground for its advocacy. Hence it comes to pass that its abolition is desirable, and that the simple division of the day into 24 hours should be established.

The example of so many places in Italy, in Bohemia, and in Poland, where this most simple division is observed at the present time, proves that its general introduction would meet with no difficulty, and that this beneficial reform could be effected without serious inconvenience; and that, besides, the logical consequence equally follows, of the possibility of the adoption of one Universal Time.

To resume: We consider we are justified in urging that, as soon as possible, the following reforms be adopted:—

1. The adoption of an initial Meridian common to all nations, the choice to be made at a conference of delegates.

2. The adoption of Cosmopolitan Time, based on this same universal Meridian, on which, moreover, naturally shall be based the computation of dates.

3. Adoption of one series of hours in one continuous day of 1 to to 24, suppressing the denominations of *anti* and *post* meridian.

4. The question of secondary Time requires to be more considered, at least in Europe. For the present we would prefer to see the national hours maintained, or, at most, we would prefer the proposition of the Swedish Commission.

* * * *

Conclusion.

Having arrived at the end of this work, we believe it is our duty to justify ourselves with the reader by some additional remarks, which may appear superfluous. But by what has been done, it will be clearly apparent that some consideration should be given to the subject It may be said to be entirely new in the scientific and geographical publications of Italy; which fact, in itself, has imposed the obligation of examining the question under its many and various aspects; when it is considered, besides, that almost all the foreign scientific and geographical publications also give the question a special prominence, either in defence of a given Meridian, or in commenting on some of the propositions which we have set forth, there is required at this time a *résumé* which all can understand; and it is now so much the more called for, as it is likely, by the invitation of the United States of America,

an International Conference will be assembled to examine the problem which we have studied.

It may now be permitted us to express the wish that the Italian Government will encourage and support the above alluded-to reunion. All civilized nations are under plain obligations to science, but Italy, from her scientific traditions, more particularly so. The country of Columbus and Galileo ought never to forget herself, and it will be no trivial honour to Italy, as indeed to all civilized nations, to sanction a reform of so much interest to science and navigation.

Whether one initial Meridian or another be adopted, is of secondary importance. What is essential is that all should agree in their decision, and all who are interested in the progress of science and civilization should strive for this result. We predict that in a short time it will be accomplished.

REPORT ON THE WASHINGTON INTERNATIONAL CONFERENCE BY MR. SANDFORD FLEMING, DELEGATE OF GREAT BRITAIN REPRESENTING THE DOMINION OF CANADA.

OTTAWA, 31st, December, 1884.

The Hon. J. A. Chapleau, Secretary of State, Canada :

SIR,—I have the honour to report for the information of His Excellency the Governor-General in Council, the proceedings of the International Conference held at Washington, for the purpose of determining a Prime Meridian and establishing a Universal Day.

I should have done so earlier, but I have only within the past few days received copies of the Protocols of the proceedings, in French and English, to place in your hands.

The Conference was held in October last. Delegates assembled representing twenty-five nationalities, viz. :—Austria, Hungary, Brazil, Chili, Columbia, Costa Rica, France, Germany, Great Britain, Guatemala, Hawaii, Italy, Japan, Liberia, Mexico, the Netherlands, Paraguay, Russia, San Domingo, Turkey, Venezuela, the United States, St. Salvador.

It was attended by myself as a delegate of Great Britain appointed to represent the Dominion of Canada.

The following gentlemen were also present on the part of Great Britain :—

1. Captain Sir F. J. O. Evans, Royal Navy.
2. Professor J. C. Adams, Director of Cambridge University.
3. Lieutenant-General Strachey, member of the Council of India.

The Delegates assembled upon the invitation of the President of the United States. They met in Conference in the Diplomatic Hall

of the Department of State. Eight sessions were held, viz. :—On October 1st, 2nd, 6th, 13th, 14th, 20th, 22nd, and on the 1st November.

After patient and careful discussion the following resolutions were carried, the Delegates, according to usage, voting by nations :—

I.

"That it is the opinion of this Conference that it is desirable to adopt a single Prime Meridian for all Nations in place of the multiplicity of initial Meridians which now exist."—*Unanimously adopted.*

II.

"That the Conference proposes to the Governments here represented the adoption of the Meridian passing through the centre of the transit instrument at the Observatory of Greenwich as the initial Meridian for longitude."—*Adopted.*

Yeas, 22. Nays, 1. Abstaining, 2.

III.

"That from this Meridian longitude shall be counted in two directions up to 180 degrees, east longitude being *plus* and west longitude *minus*."—*Adopted.*

Yeas, 14. Nays, 5. Abstaining, 6.

IV.

"That the Conference proposes the adoption of a Universal Day for all purposes for which it may be found convenient, and which shall not interfere with the use of local or other standard time where desirable."—*Adopted.*

Yeas, 23. Nays, 0. Abstaining, 2.

V.

"That this Universal Day is to be a mean solar day, is to begin for all the world at the moment of mean midnight of the initial Meridian, coinciding with the beginning of the civil day and date of that Meridian, and is to be counted from zero up to twenty-four hours."—*Adopted.*

Yeas, 15. Nays, 2. Abstaining, 7.

VI.

"That the Conference expresses the hope that as soon as may be practicable the astronomical and nautical days will be arranged everywhere to begin at mean midnight,"—*Carried without division.*

VII.

"That the Conference expresses the hope that the technical studies designed to regulate and extend the application of the decimal system to the division of angular space and of time shall be resumed so as to permit the extension of this application to all cases in which it presents real advantages."—*Adopted.*

Yeas, 21. Nays, 0. Abstaining, 3.

It was further resolved unanimously,

"That a copy of the resolutions passed by the Conference shall be communicated to the Government of the United States of America, at whose instance and within whose territory the Conference has been convened."

It will also be seen on reference to the proceedings of the last session that the thanks of the Conference were given to the President, Admiral Rodgers, of the United States Navy, and to the Sec-

retaries, General Strachey, Delegate of Great Britain, M. Janssen, Delegate of France, and Dr. Luiz Cruls, Delegate of Brazil. I was unable to attend the meeting when these votes of thanks were passed. It is most gratifying to me here to place on record my sense of the unvarying courtesy and ability on all occasions shown by the presiding officers of the Conference and by the Secretaries.

The resolutions of greatest public importance are numbers one and two, four and five. Numbers one and two relate to the determination of a Prime Meridian; numbers four and five to the establishment of the Universal Day.

The question of the Prime Meridian was not settled without argument and divergence of view. It was one, indeed, on which some national sensitiveness was to be looked for. The Delegates of France approached the discussion with marked earnestness. They presented a resolution claiming that the Meridian to be selected should possess a character of absolute neutrality. "It should," ran the resolution (page 36), "be chosen exclusively so as to secure to science and to international commerce all possible advantages, and especially cut no great continent, neither Europe nor America."

Under the circumstances I felt it my duty to submit the remarks given in the protocol of the fourth session (pp. 75, 80).* I endeavoured to argue that our deliberations should take into consideration future demands and emergencies, while at the same time our decisions should cause as little interference as possible with present customs, and that we should consult the convenience of the greatest number; that we should especially regard national sensitiveness. I contended that to choose and recommend a neutral Meridian would simply be an attempt to establish an entirely new Meridian, one not in use by any individual nationality or by the shipping of any country. Even if such were recommended by the majority of Delegates there would be no guarantee, indeed there was no probability, that it would be accepted by any one of the twenty-five nationalities represented at the Conference. Eleven Meridians are already in use as zeros of longitude. The proposition, if it led to any result, would create a twelfth Meridian, and it would practically increase the difficulty we were endeavouring to remove.

The advantages to sea-going vessels having one common zero of longitude were incalculable. They had been alluded to by the President of the Conference in his opening address. I expressed my concurrence with his views, and pointed out that by the judicious establishment of the Prime Meridian we could the more readily reach the question of Universal Time. It was not from any national reason that the Meridian of Greenwich suggested itself as the one to be chosen. It was because of its convenience and its general use by the great majority of sea-going ships.

* Appended, page 74.

If the Meridian of Greenwich were established it would possess simply the character which its selection by the Conference would give it. It would become the Prime Meridian of the whole world—its national character would disappear. The words "Greenwich Meridian" would really have no place upon charts. The proper terms to be used by all hydrographers and navigators would be "Prime Meridian" or "Zero."

The vote for the Meridian of Greenwich was nearly unanimous, only one nation, San Domingo, voting against it But before the vote was arrived at I deemed it proper, in order to meet the objections that had been raised, to submit a proposition leaving it an open question, to be settled by a subsequent vote, whether the choice should fall on the Meridian or anti-Meridian of Greenwich.

This proposition did not receive support. The majority felt the question was best decided by the direct motion establishing the Meridian of Greenwich as the Prime Meridian.

It will be seen by the third resolution that the mode of reckoning longitude remains unchanged—it is to be counted in two directions from the Prime Meridian up to 180 degrees, east longitude *plus* and west longitude *minus*.

Looking to the ulterior proceedings of the Conference, I felt it my duty to point out that a new nomenclature of longitude could be advantageously introduced; that although inconveniences would at first be felt in effecting a change in a custom so long followed, these would be far outweighed by the general benefits to be derived in future years. My own feeling was in favour of extreme simplicity of system, of a notation in complete harmony with the scheme of Universal Time. I held that it would be best to abandon counting longitude in two directions; that it should be reckoned in one direction only; that the Meridians should be numbered continuously from zero towards the west, avoiding the expressions *plus* and *minus* to denote east and west longitude.

Various authorities may be cited in support of these views. According to the distinguished astronomer, Sir John Herschel, longitude may be expressed in hours equally as well as in degrees, and "it would add greatly to systematic regularity, and tend much to avoid confusion and ambiguity in computations, were this mode of expression (longitude East and West) abandoned and longitudes reckoned invariably westward from their origin, around the whole circle."

In view of the adoption of Universal Time, it seemed to me obvious that great benefits would result if longitudes were reckoned on the same principle and known by the same terms as those which would be used in the new system of Time. I venture to draw attention to the remarks which I felt called upon to submit on the point (pp. 116,

122, and 124).* My own colleagues from Great Britain were not in accord with these views.

When the question of Universal Time was discussed, the Conference showed great unanimity with regard to its adoption for all purposes for which it may be found convenient. The principle was confirmed by the fourth resolution, and the division shows that while twenty-three nations voted in its favour, through their representatives, not a single delegate voted against the resolution.

The Universal Day is to be the mean Solar Day, commencing at the moment of mean mid-night of the Prime Meridian. The hours to be counted in one series up to twenty-four. Twelve o'clock of the new time will take place at the moment of mean noon at Greenwich, and the hours of the second half of the day will range from thirteen to twenty-four.

The resolution adopting the Prime Meridian having been carried, the establishment of a system of Universal Time became possible. I felt it my duty to submit the opinion I held on the question at some length (pp. 117, 125, and 181).† I endeavoured to point out that the condition of the age demanded a system of computing time which should have in view :

1. To secure chronological accuracy in dates common to the whole world.

1. To obtain a Standard of Time measurement, on a basis accepted by all nations, by which everywhere synchronously the same instant may be observed.

3. To establish a sound rational system of reckoning Time, which may eventually be adopted for civil purposes everywhere, and thus secure uniformity throughout the globe, with the greatest possible accuracy.

I ventured to submit to the Conference a series of recommendations designed to meet these ends. They embraced a scheme of Universal Time which, in its essential features, had for some years been under consideration by scientific bodies.

The Conference did not consider it necessary to decide upon details.

The resolutions passed are to the following effect, viz. :—

1. The advantages of Universal Time are recognized.

2. The Universal Day is defined.

3. While the Meridian of Greenwich is chosen as the Prime Meridian and the zero of longitude, the anti-Prime Meridian becomes the zero of Time.

4. The hours of the Universal Day are to be counted in one series from zero up to twenty-four.

* Appended, page 77.

† Appended, page 77 to 82.

5. The zero of the hours is the moment of mean solar passage on the anti-Prime Meridian. The first hour is at the moment of mean solar passage on the Meridian 15° west of the anti-Prime Meridian; the second and the remaining hours of the Universal Day come in turn at the solar passage on successive Meridians 15° of longitude apart, each Hour-meridian being an exact multiple of 15° from zero.

Thus a series of twenty-four Hour-meridians are practically determined around the globe, corresponding with the twenty-four hours of the Universal Day. A principle of uniformity will consequently be secured when the system of regulating civil time by Hour-standards comes to be adopted in other countries. It has already been acted upon in Canada and the United States with signal success.

I have already stated that the principle of Universal Time was adopted by the vote of twenty-three nations, and the division shows that while the representatives of two nations abstained from voting, no negative vote was cast against it. The recognition now given by authority to this new mode of Time-reckoning is of great importance. To my mind, it is far-reaching in its consequences, and obviously a step towards the unification of Time throughout the world. It will doubtless depend greatly on circumstances when and to what extent this new system will be introduced into civil life. No arbitrary line can be drawn to prescribe its applicability. It is only from use and convenience that the practical limit will be found. In course of years the uses and advantages of Universal Time will be better understood, and that which to this generation may appear strange and extraordinary, to the one succeeding may be regarded as regular and normal.

I trust I may be allowed to state that the principles of Universal Time adopted by the Conference are identical in character with those set forth in some papers which were published in Canada six years back. It was the Council of the Canadian Institute, Toronto, who took the initiative in bringing the subject before the world in 1879. This body memorialized the then Governor-General, Lord Lorne, on the subject, submitting documents on Time-reckoning and the selection of a Prime Meridian to be common to all nations. It was through His Excellency's official and personal weight and influence that copies of these papers were brought under the notice of the Imperial Government. Through the intervention of the Imperial Government they were submitted to the Governments of the civilized nations, and became known to men of science and high reputation. His Excellency evinced a deep interest in the question, and under his distinguished auspices the attention of Scientific Societies in Europe was first awakened to the subject.

More recently the Canadian Institute appointed a Delegate to the International Geographical Congress, held at Venice in 1881, to pro-

mote the discussion of the question. On this occasion the Canadian Delegate was permitted to submit a series of resolutions pointing out that it was eminently desirable that civilized nations should come to an agreement with respect to the determination of a common Prime Meridian and a system of Universal Time. The resolutions further suggested that Delegates should be appointed by the different Governments to meet in Conference at Washington to discuss these questions. The resolutions met with the active and cordial support of gentlemen from the United States representing Scientific Societies and the United States Government at the Venice Congress.

There cannot be a doubt that the proceedings at Venice led to the important action taken by the International Geodetic Congress at Rome in 1883, which in its turn has greatly assisted in preparing the way for the work of the Washington Conference.

On this side of the Atlantic, the Canadian Institute has not been the only active body. The progress of the movement has been greatly influenced by Societies in the United States, notably the American Metrological Society and the American Society of Civil Engineers. Those societies have systematically considered the question, and directed the attention of the public and the United States Government to it.

In submitting the proceedings of the Conference at Washington, I have alluded to some of the principal agencies which have operated to bring about the conclusion now reached. I trust that it will not be held an impropriety on my part thus dwelling upon the important part Canada has played in the establishment of Universal Time, and in the determination of an initial Prime Meridian for the world. With two copies of the protocols which I have the honour to enclose, I also forward copies of the documents issued by the Canadian Institute.

I have the honour to be,

Sir,

Your obedient servant,

SANDFORD FLEMING.

APPENDIX TO REPORT ON THE WASHINGTON CONFERENCE.

Extract (1) from the Protocols of Session, October 13th, referred to in the foregoing Report, page 69.

Mr. Sandford Fleming, Delegate of Great Britain:—I have listened with great attention and deep interest to the remarks which have fallen from the several gentlemen who have spoken, and I desire your kind indulgence for a few moments while I explain the views I have formed on the motion of the distinguished Delegates from France.

I feel that the important question which this Conference has to consider must be approached in no narrow spirit. It is one which affects every nationality, and we should endeavour, in the common interest, to set aside any national or individual prejudices we possess, and view the subject as members of one community—in fact, as citizens of the world. Acting in this broad spirit, we cannot fail to arrive at conclusions which will promote the common good of mankind.

In deliberating on the important subject before us, it seems to me there are two essential points which we should constantly bear in mind.

1. We should consider what will best promote the general advantage, not now only, but for all future years, while causing at the present time as little individual and national inconvenience as possible.

2. We should, in coming to a determination on the main question for which this Conference is called, leave nothing undone to avoid offence, now or hereafter, to the sensitiveness of individual nations.

The motion is, that the initial meridian to be chosen should be selected on account of its neutrality. This undoubtedly involves the selection of an entirely new meridian, one which has never previously been used by any nation, as all initial meridians in use are more or less national, and, as such, would not be considered neutral in the sense intended by the honourable Delegates from France.

Let us suppose that this Conference adopted the motion. Let us suppose, further, that we found a meridian quite independent of, and unrelated to any existing initial meridian. Would we then have accomplished the task for which we are met? I ask, would the twenty-six nations here represented accept our recommendation to adopt the neutral meridian? I greatly fear that the passing of the resolution would not in the least promote the settlement of the important question before the Conference. The world has already at least eleven different first meridians. The adoption of the new meridian contemplated by the Delegates from France would, I apprehend, simply increase the number and proportionately increase the difficulty which so many Delegates from all parts of the earth are assembled here to remove.

This would be the practical effect of the passing of the resolution. If it had any effect, it would increase the difficulty, and I need not say that is not the object which the different Governments had in view when they sent Delegates to this Conference. The President has well pointed out in his opening address the advantages which would be gained, and the great dangers which, at times, would be avoided by seafaring vessels having one common zero of longitude. Besides the benefits which would accrue to navigation, there are advantages of equal importance in connection with the regulation of Time, to spring, I trust, from our conclusions.

It does not appear to me that the adoption of the motion would in any way advance these objects. I do not say that the principle of a neutral meridian is wrong, but to attempt to establish one would, I feel satisfied, be productive of no good result. A neutral meridian is excellent in theory, but I fear it is en-

tirely beyond the domain of practicability. If such be the case, it becomes necessary to consider how far it would be practicable to secure the desired advantages by adopting as a zero some other meridian which, while related to some existing first meridian, would not be national in fact, and would have the same effect as a perfectly neutral meridian in allaying national susceptibilities.

The selection of an initial meridian related to meridians now in use gives us a sufficiently wide choice. Allow me to read the following list, showing the number and the total tonnage of vessels using the several meridians named, in ascertaining their longitude :—

INITIAL MERIDIANS.	SHIPS OF ALL KINDS.		PER CENT.	
	Number.	Tonnage.	Ships.	Tonnage.
Greenwich	37,663	14,600,972	65	72
Paris	5,914	1,735,083	10	8
Cadiz	2,468	666,602	5	3
Naples	2,263	715,448	4	4
Christiania	2,128	695,988	4	3
Ferro	1,497	567,682	2	3
Pulkova	987	298,641	1½	1½
Stockholm	717	154,180	1½	1
Lisbon	491	164,000	1	1
Copenhagen	435	81,888	1	½
Rio de Janeiro	253	97,040	½	½
Miscellaneous	2,881	534,569	4½	2½
Total	57,697	20,312,093	100	100

It thus appears that one of these meridians, that of Greenwich, is used by 72 per cent. of the whole floating commerce of the world, while the remaining 28 per cent is divided among ten different initial meridians. If, then, the convenience of the greatest number alone should predominate, there can be no difficulty in a choice ; but Greenwich is a national meridian, and its use as an international zero awakens national susceptibilities. It is possible, however, to a great extent, to remove this objection by taking, for a zero of Longitude and Time, the meridian farthest distant from Greenwich. This being on the same great circle as Greenwich, it would not require the establishment of a new observatory ; its adoption would produce no change in charts or nautical tables, beyond the notation of longitude. It would possess all the advantage claimed for the Greenwich meridian in connection with navigation, and as a zero for regulating Time it would be greatly to be preferred to the Greenwich meridian. This Pacific meridian being accepted as the common zero, and longitude being reckoned continuously in one direction, there would be an end to the necessity of any nation engraving on its charts the word "longitude east or west of Greenwich." The one word, "Longitude" would suffice. The zero meridian would be international and in no respect national. Even on British charts all reference to Greenwich would disappear.

This view of the question is sustained by many distinguished men. I shall only ask permission to read the opinion of Mr. Otto Struve, Director of the Imperial Observatory at Pulkova, than whom there is no higher authority.

"The preference given to the Greenwich meridian was based, on one side, on the historical right of the Royal Observatory of England, acquired by eminent services rendered by this establishment during the course of two centuries, to mathematical geography and navigation ; on the other side, considering that the great majority of charts now in use upon all the seas are made according to this meridian, and about 90 per cent. of the navigators of long

standing are accustomed to take their longitude from this meridian. However, an objection against this proposition is, that the meridian of Greenwich passes through two countries of Europe, and thus the longitude would be reckoned by different signs in different portions of our own continent and also of Africa.

"Moreover, the close proximity of the meridian of Paris, which, perhaps, some French geographers and navigators of other nations would still hold to, from custom, from a spirit of contradiction or from national rivalry, might easily cause sad disaster. To obviate these inconveniences, I have proposed to choose as Prime meridian another meridian, situated at an integral number of hours east or west of Greenwich, and among the meridians meeting this condition, I have indicated, in the first place, the meridian proposed to-day by scientific Americans, as that which would combine the most favorable conditions for its adoption. Thus the meridian situated 180° from Greenwich presents the following advantages :—

"1. It does not cross any continent but the eastern extremity of the North of Asia, inhabited by people very few in number and little civilized, called Tschouktschis.

"2. It coincides exactly with that line where, after the custom introduced by a historical succession of maritime discoveries, the navigator makes a change of one unit in the date, a difference which is made near a number of small islands in the Pacific Ocean, discovered during the voyages made to the east and west. Thus the commencement of a new date would be identical with that of the hours of Cosmopolitan Time.

"3. It makes no change to the great majority of navigators and hydrographers, except the very simple addition of twelve hours, or of 180° to all longitudes.

"4. It does not involve any change in the calculations of the Ephemerides most in use among navigators, viz., the English Nautical Almanac, except turning mid-day into mid-night, and *vice versa*. In the American Nautical Almanac there would be no other change to introduce. With a cosmopolitan spirit, and in the just appreciation of a general want, the excellent Ephemerides published at Washington, record all data useful to navigators calculated from the meridian of Greenwich.

"For universal adoption, as proposed by the Canadian Institute, it recommends itself to the inhabitants of all civilized countries, by reason of the great difference in longitude, thus removing all the misunderstandings and uncertainties concerning the question, as to whether, in any case, Cosmopolitan or Local Time was used.

"In answer to the first question offered by the Institute at Toronto, I would, therefore, recommend the Academy to pronounce without hesitation in favour of the universal adoption of the meridian situated 180° from Greenwich, as Prime Meridian of the globe."

I quote from the report of M. Otto Struve to the Imperial Academy of Sciences of St. Petersburg, 30th Sept. 1880.

I respectfully submit, we have thus the means of solving the problem presented to us, without attempting to find such a meridian as that contemplated in the motion of the honorable delegates. Whatever its origin, the Pacific meridian referred to would soon be recognized as being as much neutral as any meridian could possibly be. If, on the other hand, we adopt the motion, I very greatly fear that the main object of this Conference will be defeated and the settlement of a question so pregnant with advantages to the world will be indefinitely postponed.

Extract (2) from the Protocols of Session, October 14th, referred to in the foregoing Report, page 71.

Mr. Sandford Fleming, Delegate of Great Britain, representing the Dominion of Canada:—I wish to offer some observations on the resolution before the Conference, but I am unable to separate the particular question from the general question. To my mind, longitude and time are so related that they are practically inseparable, and when I consider longitude, my thoughts naturally revert to time, by which it is measured. I trust, therefore, I may be permitted to extend my remarks somewhat beyond the immediate scope of the resolution. I agree with those who think that longitude should be reckoned in one direction only, and I am disposed to favour a mode of notation differing in other respects from that commonly followed.

If a system of universal time be brought into use, advantages would result from having the system of time and the system of terrestrial longitude in complete harmony. The passage of time is continuous, and, therefore, I think longitude should be reckoned continuously. To convey my meaning fully, however, it is necessary that I should enter into explanations at some length.

The adoption of a Prime Meridian, common to all nations, admits of the establishment of a system of reckoning time equally satisfactory to our reason and our necessities.

At present we are without such a system. The mode of notation followed by common usage from time immemorial, whatever its applicability to limited areas, when extended to a vast continent, with a net-work of lines of railway and telegraph, has led to confusion and created many difficulties. Further, it is insufficient for the purposes of scientific investigation, so marked a feature of modern inquiry.

Taking the globe as a whole, it is not now possible precisely to define when a year or a month or a week begins. There is no such interval of time as the commonly defined day everywhere and invariable. By our accepted definition, a day is local; it is limited to a single meridian. At some point on the earth's surface one day is always at its commencement and another always ending. Thus, while the earth makes one diurnal revolution, we have continually many days in different stages of progress on our planet.

Necessarily the hours and minutes partake of this normal irregularity. Clocks, the most perfect in mechanism, disagree if they differ in longitude. Indeed, if clocks are set to true time, as it is now understood, they must, at least in theory, vary not only in the same State or County, but to some extent in the same City.

As we contemplate the general advance in knowledge, we cannot but feel surprised that these ambiguities and anomalies should be found, especially as they have been so long known and felt. In the early conditions of the human race, when existence was free from the complications which civilization has led to; in the days when tribes followed pastoral pursuits and each community was isolated from the other; when commerce was confined to few cities, and intercommunication between distant countries rare and difficult; in those days there was no requirement for a common system of uniform time. No inconvenience was felt in each locality having its own separate and distinct reckoning. But the conditions under which we live are no longer the same. The application of science to the means of locomotion and to the instantaneous transmission of thought and speech have gradually contracted space and annihilated distance. The whole world is drawn into immediate neighbourhood and near relationship, and we have now become sensible to inconveniences and to many disturbing influences in our reckoning of time utterly unknown and even unthought of a few generations back. It is also quite manifest that, as civilization advances, such evils must greatly increase rather than be lessened, and that the true remedy lies in changing our traditional usages in respect to

the notation of days and hours, whatever shock it may give to old customs and he prejudices engendered by them.

In countries of limited extent, the difficulty is easily grappled with. By general understanding, an arrangement affecting the particular community may be observed, and the false principles which have led to the differences and disagreements can be set aside. In Great Britain the time of the Observatory at Greenwich is adopted for general use. But this involves a departure from the principles by which time is locally determined, and hence, if these principles be not wrong, every clock in the United Kingdom, except those on a line due north and south from Greenwich, must of necessity be in error.

On the continent of North America efforts have recently been made to adjust the difficulty. The steps taken have been in a high degree successful in providing a remedy for the disturbing influences referred to, and, at the same time, they are in harmony with principles, the soundness of which is indisputable.

When we examine into time in the abstract, the conviction is forced upon us that it bears no resemblance to any sort of matter which comes before our senses; it is immaterial, without form, without substance, without spiritual essence. It is neither solid, liquid, nor gaseous. Yet it is capable of measurement with the closest precision. Nevertheless, it may be doubted if anything measurable could be computed on principles more erroneous than those which now prevail with regard to it.

What course do we follow in reckoning time? Our system implies that there are innumerable conceptions designated "time." We speak of solar, astronomical, nautical, and civil time, of apparent and mean time. Moreover, we assign to every individual point around the surface of the earth separate and distinct times in equal variety. The usages inherited by us imply that there is an infinite number of times. Is not all this inconsistent with reason, and at variance with the cardinal truth, that there is *one time only?*

Time may be compared to a great stream forever flowing onward. To us, nature, in its widest amplitude, is a unity. We have but one Earth, but one Universe, whatever its myriad component parts. That there is also but one flow of Time is consistent with the plain dictates of our understanding. That there can be more than one passage of Time is inconceivable.

From every consideration, it is evident that the day has arrived when our method of Time-reckoning should be reformed. The conditions of modern civilization demand that a comprehensive system should be established, embodying the principal that *Time is one abstract conception*, and that all definite portions of it should be based on, or be related to, *one unit measure*.

On these grounds I feel justified in respectfully asking the consideration of the Conference to the series of recommendations which I venture to submit.

The matter is undoubtedly one in which every civilized nation is interested. Indeed, it may be said that, more or less, every human being is concerned in it. The problem is of universal importance, and its solution can alone be found in the general adoption of a system grounded on principles recognized as incontrovertible.

Such principles are embodied in the recommendations which I am permitted to place before the Conference. They involve, as an essential requirement, the determination of a unit of measurement, and it is obvious that such a unit must have its origin in the motion of the heavenly bodies. No motion is more uniform than the motion of the earth on its axis. This diurnal revolution admits of the most delicate measurement, and, in all respects, is the most available for a unit measure. It furnishes a division of time definite and precise, and one which, without difficulty, can be made plain and manifest.

A revolution of the earth, denoted by the mean solar passage at the Prime or Anti-prime Meridian, will be recognizable by the whole world as a period of time common to all. By general agreement this period may be regarded as the common unit by which Time may be everywhere measured for every purpose in science, in commerce, and in every-day life.

The scheme set forth in the recommendations has in view three principal objects, viz:

1. To define and establish an Universal Day for securing chronological accuracy in dates common to the whole world.

2. To obtain a system of Universal Time on a basis acceptable to all nations, by which, everywhere, at the same time, the same instant may be observed.

3. To establish a sound and rational system of reckoning Time which may eventually be adopted for civil purposes everywhere, and thus secure uniformity and accuracy throughout the globe.

But, in the inauguration of a scheme affecting so many individuals, it is desirable not to interfere with prevailing customs more than necessary. Such influences as arise from habit are powerful and cannot be ignored. The fact must be recognized that it will be difficult to change immediately the usages to which the mass of men have been accustomed. In daily life we are in the habit of eating, sleeping, and following the routine of our existence at certain periods of the day. We are familiar with the numbers of the hours by which these periods are known, and, doubtless, there will be many who will see little reason in any attempt to alter their nomenclature, especially those who take little note of cause and effect, and who, with difficulty, understand the necessity of a remedy to some marked irregularity, which, however generally objectionable, does not bear heavily upon them individually.

For the present, therefore, we must adapt a new system, as best we are able, to the habits of men and women as we find them. Provision for such adaptation is made in the recommendations by which, while local reckoning would be based on the principles laid down, the hours and their numbers need not appreciably vary from those with which we are familiar. Thus, Time-reckoning in all ordinary affairs in every locality may be made to harmonize with the general system.

Standard Time throughout the United States and Canada has been established in accord with this principle. Its adoption has proved the advantages which may be attained generally by the same means. On all sides these advantages have been widely appreciated, and no change intimately bearing upon common life was ever so unanimously accepted. Certainly, it is an important step towards the establishment of one system of Universal Time, or, as it is designated in the recommendations, Cosmic Time.

The alacrity and unanimity with which the change has been accepted in North America encourages the belief that the introduction of Cosmic Time in every-day life is not unattainable. The intelligence of the people will not fail to discover before long, that the adoption of correct principles of Time-reckoning will in no way change or seriously affect the habits they have been accustomed to. It will certainly sweep away nothing valuable to them. The sun will rise and set to regulate their social affairs. All classes will soon learn to understand the hour of noon, whatever the number on the dial, whether six, as in Scriptural times, or twelve, or eighteen, or any other number. People will get up and retire to bed, begin and end work, take breakfast and dinner at the same periods of the day as at present, and our social habits and customs will remain without a change, depending, as now, on the daily returning phenomena of light and darkness.

The one alteration will be in the notation of the hours, so as to secure uniformity in every longitude. It is to be expected that this change will at first create some bewilderment, and that it will be somewhat difficult to be under-

stood by the masses. The causes for such a change to many will appear insufficient or fanciful. In a few years, however, this feeling must pass away, and the advantages to be gained will become so manifest that I do not doubt so desirable a reform will eventually commend itself to general favour, and be adopted in all the affairs of life.

Be that as it may, it seems to me highly important that a comprehensive Time-system should be initiated to facilitate scientific observations, and definitely to establish chronological dates; that it should be designed for general use in connection with railways and telegraphs, and for such other purposes for which it may be found convenient.

The Cosmic Day set forth in the recommendations would be the date for the world recognizable by all nations. It would theoretically and practically be the mean of all local days, and the common standard to which all local reckonings would be referable.

With regard to the reckoning of longitude, I submit that Longitude and Time are so intimately related that they may be expressed by a common notation. Longitude is simply the angle formed by two planes passing through the earth's axis, while Time is the period occupied by the earth in rotating through that angle. If we adopt the system of measuring Time by the revolution of the earth from a recognized zero, one of these planes—that through the zero—may be considered fixed; the other—that through the meridian of the place—being movable, the longitudinal angle is variable. Obviously the variable angle ought to be measured from the fixed plane as zero, and as the motion of the earth by which the equivalent time of the angle is measured is continuous, the longitude ought to be reckoned continuously in one direction. The direction is determined by the notation of the Hour-meridians, viz., from east to west.

If Longitude be so reckoned and denoted by the terms used in the notation of Cosmic Time, the time of day everywhere throughout the globe would invariably denote the precise longitude of the place directly under the mean sun. Conversely, at the epoch of mean solar passage at any place, the Longitude being known, Cosmic Time would be one and the same with the Longitude of the place.

The advantages of such a system of reckoning and nomenclature, as suggested in the recommendations which I now submit, will be, I think, self-evident.

RECOMMENDATIONS FOR THE REGULATION OF TIME AND THE RECKONING OF LONGITUDE.

1. *That a system of Universal Time be established, with the view of facilitating synchronous scientific observations, for chronological reckonings, for the purpose of trade and commerce by sea and land, and for all such uses to which it is applicable.*

2. *That the system be established for the common observance of all peoples, and of such a character that it may be adopted by each separate community, as may be found expedient.*

3. *That the system be based on the principle that for all terrestrial Time-reckonings there be one recognized unit of measurement only, and that all measured intervals of Time be directly related to the one unit measure.*

4. *That the unit measure be the period occupied by the diurnal revolution of the earth, defined by the mean solar passage at the meridian twelve hours from the Prime Meridian established through Greenwich.*

5. *That the unit measure defined as above be held to be a Day absolute, and designated a Cosmic Day.*

6. *That such Cosmic Day be held as the chronological date of the earth, changing with the mean solar passage at the Anti-meridian of Greenwich.*

7. *That all divisions and multiples of the Cosmic Day be known as Cosmic Time.*

8. *That the Cosmic Day be divided into hours, numbered in a single series, one to twenty-four* (1 *to* 24), *and that the hours be sub-divided, as ordinary hours, into minutes and seconds.* NOTE.—*As an alternative means of distinguishing the Cosmic hours from the hours in local reckonings, they may be denoted by the letters of the alphabet, which, omitting I and V, are twenty-four in number.*

9. *That until Cosmic Time be admitted as the recognized means of reckoning in the ordinary affairs of life, it is advisable to assimilate the system to present usages, and to provide for the easy translation of local reckonings into Cosmic Time, and vice versa; that, therefore, in theory, and as closely as possible in practice, local reckonings be based on a known interval in advance or behind Cosmic Time.*

10. *That the surface of the globe be divided by twenty-four equi-distant Hour-meridians, corresponding with the hours of the Cosmic Day.*

11. *That, as far as practicable, the several Hour-meridians be taken according to the longitude of the locality, to regulate local reckonings, in a manner similar to the system in use throughout North America.*

12. *That in all cases where an Hour-meridian is adopted as the standard for regulating local reckonings in a particular section or district, the civil day shall be held to commence twelve hours before, and end twelve hours after, the mean solar passage of such Hour Meridian.*

13. *That the civil day, based on the Prime Meridian of Greenwich, shall coincide and be one with the Cosmic Day. That civil days on meridians east of Greenwich shall be* (*according to the longitude*) *a known number of hours, or hours and minutes, in advance of Cosmic Time, and to the west of Greenwich the contrary.*

14. *That the surface of the globe being divided by twenty-four equi-distant meridians* (*fifteen degrees apart*) *corresponding with the hours of the Cosmic Day, it is advisable that longitude be reckoned according to these Hour-meridians.*

15. *That divisions of longitude less than an hour* (*fifteen degrees*) *be reckoned in minutes and seconds and parts of seconds.*

16. *That longitude be reckoned continuously towards the west, beginning with zero at the Anti-prime Meridian, twelve hours from Greenwich.*

17. *That longitude generally be denoted by the same terms as those applied to Cosmic Time.*

I submit these recommendations suggestively, and without any desire unduly to press them. I shall be content if the leading principles laid down be recognized by the Conference.

With regard to the more immediate question, I have come to the firm conviction that extreme simplicity of reckoning and corresponding benefits would result if Longitude be notated in the same manner, and denoted by the same terms, as Universal Time. If, therefore, the Conference adopts the notation of the distinguished Delegate of the United States, which, I apprehend, is designed to cause as little change as possible in the practices of sea-faring men, I trust the claims of other important interests will not be overlooked. I refer to all those interests so deeply concerned in securing accurate time on land, and in having easy means provided for translating any one local reckoning into any other local reckoning, or into the Standard Universal Time. In this view I trust the Conference will give some expression of opinion in favour of extending around the globe the system of Hour-meridians which has proved so advantageous in North America. In an educational aspect alone it seems to me important that the Hour-meridians, one to twenty-four, numbered from the Anti-prime Meridian continuously toward the west, should be conspicuously marked on our maps and charts.

Extract (3) from the Protocols of Session 20th October, referred to in the foregoing Report, page 71.

Mr. Sandford Fleming, Delegate of Great Britain:—To my mind it is of very great importance that this resolution should be adopted. I have already given generally my views on this question, and therefore I do not intend to trespass on the attention of the Conference beyond saying a very few words. From what I have already ventured to submit, it will be obvious that I hold that all our usages in respect to the reckoning of time are arbitrary. Of one thing there can be no doubt. There is only one, and there can only be one flow of Time, although our inherited usages have given us a chaotic number of arbitrary reckonings of this one conception. There can be no doubt of another matter; the progress of civilization requires a simple and more rational system than we now possess. We have, it seems to me, reached a stage when a unification of the infinite number of time-reckonings is demanded.

This unification will be, to a large extent, accomplished if the resolution be adopted, and by adopting it, it seems to me to be in the power of the Conference to confer lasting benefits on the world.

Universal Time will in no way interfere with local time. Each separate community may continue in the usages of the past in respect to local time, or may accept whatever change the peculiar conditions in each case may call for. But the use of Universal Time will not necessarily involve a change; it will rather be something added to what all now possess, and it will be a boon to those who avail themselves of it.

To the east of the Prime Meridian all possible local days will be in advance; to the west all possible days will be behind the Universal Day.

The Universal Day, as defined by the resolution, will at once be the mean of all possible local days, and the standard to which they will all be related by a certain known interval, that interval being determined by the longitude.

In my judgment, the resolution is an exceedingly proper one, and the Conference will act wisely in passing it.

HIS EXCELLENCY THE GOVERNOR-GENERAL, CANADA, TO THE PRESIDENT OF THE CANADIAN INSTITUTE.

OFFICE OF THE GOVERNOR-GENERAL'S SECRETARY,
OTTAWA, 8th April, 1885.

SIR,—I have the honour, by desire of His Excellency the Governor-General, to transmit to you herewith a copy of a despatch (No. 48, 17th March,) from the Secretary of State for the Colonies, expressing the high appreciation of Her Majesty's Government of the services rendered by Mr. Sandford Fleming, C.M.G., in connection with the Prime Meridian Conference at Washington.

I have the honour to be.

Sir,

Your obedient servant,

CHARLES J. JONES,
For the Governor-General's Secretary.

The President Canadian Institute, Toronto.

THE EARL OF DERBY, SECRETARY OF STATE FOR THE COLONIES, TO HIS EXCELLENCY THE MARQUIS OF LANSDOWNE, GOVERNOR-GENERAL OF CANADA.

DOWNING STREET, 17th March, 1885.

MY LORD,—I have the honour to acknowledge the receipt of your Despatch No. 53, of the 24th ultimo, with its enclosures, respecting the proceedings of the Prime Meridian Conference at Washington.

I have caused the papers forwarded to be transmitted to the Science and Art Department.

I take this opportunity to request your Lordship to inform Mr. Sandford Fleming that Her Majesty's Government highly appreciate the services rendered by him in connection with this Conference.

I have, &c.,

DERBY.

GOVERNOR-GENERAL,
The Most Hon. the Marquis of Lansdowne, G.C.M.G., &c., &c., &c.

THE RESOLUTIONS OF THE WASHINGTON MERIDIAN CONFERENCE.

BY OTTO STRUVE,

DIRECTOR OF THE IMPERIAL ASTRONOMICAL OBSERVATORY, PULTOWA, RUSSIA.

[*Translated from the German, published in St. Petersburg, 1885.*]

It has been felt as a positive evil, for a long time, throughout the civilized world, and especially with geographers and navigators, that in different countries the degrees of geographical longitude are referred to different initial meridians. This multiplication of initial meridians to which, as they are in prominence, these lines of longitude are adapted, and which in each particular country correspond to the most important observatories, not only causes great complications by the contemporary use in different countries of the several published geographical maps, but is likewise for navigators a source of error which can easily lead to mischievous results, and indeed has so led to them. Therefore, for centuries the desire has been very widely entertained for the common acceptance by all nations of one and the same Meridian as the starting point for the enumeration of the lines of Longitude, by which means this evil would be removed. In the programme of the first Geographical Congress, proposed to be held at Antwerp, in the summer of 1870, public attention was specially directed to this question, as the most important subject for consideration; indeed to a certain extent as the chief object to be submitted to the Congress. On account of the German-French war, unfortunately the Congress called for that year was not held; and although since that date the same question has been the subject of preparatory discussion in later Congresses and Public Conferences, nevertheless the first decided advance in the matter was through the Congress of Delegates of almost every civilized country in the world, called together in October of last year, in Washington, by the Government of the United States of North America. The most important of the Resolutions adopted at this International Conference we design here somewhat closely to discuss.

It is proper to remark, that for a long period with us in Russia preparatory measures have been taken in the same direction as that which at the Washington Conference was suggested to be followed by the whole world. As a proof, it may be said that Mr. Struve, shortly after the successful establishment of the Chief Observatory in Pultowa, in the most positive manner pronounced against the establishment of a special First Meridian in Russian Cartography. In accordance with this view, in 1843–44 he organized the great Chronometer Expedition, by which the difference of Longitude between Pultowa and Greenwich was established with the utmost precision, so that in Russia we were in a position to lay down all lines of Longitude, determined or to be determined, with perfect correct-

ness with regard to the Meridian of the last named Observatory, which already at that time was the most generally in use.

His Imperial Highness the Grand Duke Constantine Nicolajewitch, also acted, in the same enlightened and liberal spirit, when in his position as High Admiral of the Russian Fleet, which, until 1853, had made use of a Nautical Almanack specially prepared for Russia, he cancelled its use, and in its place introduced into the Russian Navy the English Nautical Almanack, well known as based on the Greenwich Meridian, from which the *Morski Miesiatseslob* (Naval Almanac) was essentially a stunted re-production. A far more important step was taken, that since that period upon his order, the Lines of Longitude according to the Meridian of Greenwich are drawn on all Sea Charts produced by the Hydrographical Department, and only on the margin of the Map their relation to Pultowa is marked. In spite of this precedent, we have in the meantime remained not entirely free from the influence of the unwise feeling of nationality which has advanced the claim of Pultowa to be the First Meridian at least for Russia. It is owing to such national feeling that the fact must be explained that upon several Maps issued by the Head Quarter Staff, in contradiction to the views of the Pultowa astronomers, even in instances where the Maps have not simply a local interest, the Lines of Longitude are referred to Pultowa, and on the margin only the relation which that Meridian bears to Greenwich is shewn.

As already mentioned, this matter took a new phase through the Antwerp programme, and the interest we felt in the proceedings, became accordingly the more marked. Especially, the aim of the Unification of Longitude found a zealous representative in the person of the then President of the Imperial Academy of Sciences, Admiral Count Lütke. Among other matters he induced the present Director of the Pultowa Observatory publicly to set forth his views upon this question, and in accordance with this desire, the latter prepared a paper which he read at a general meeting of the Imperial Russian Geographical Society, held on the 4th February, 1870. In this paper, the conclusions of which the meeting approved, among other points discussed, the arguments which may be adduced in advocacy of the Meridian of Greenwich for universal acceptance as First Meridian, were sufficiently set forth. The argument suggested that should the immediate acceptance of this Meridian, on account of mistaken national feeling, obtain not only a merely apparent support, but on the other hand experience serious opposition from the circumstance, that it serves to determine longitude, as well for Great Britain as for France, conditionally on a change of notation, so might it be an acceptable arrangement that the First Meridian to be named should be drawn from that of Greenwich, at a given number of hours, without any addition of minutes and seconds. The reader of the paper under such circumstances took

upon himself to direct special attention to a Meridian twelve hours distant from Greenwich, which passes through firm land only in the high latitudes of the north in the uninhabited neighbourhood of Tschuktschenland, near Behring Straits, and for the remaining part of the distance runs through the Pacific Ocean and the two Arctic seas of ice. The establishment of this Meridian, which may be described as the nether Greenwich Meridian, would in any circumstance lead to fewer practical inconveniences than those incident to any other Meridian excepting that of Greenwich itself.

These views not only found much accord in this country, but were also favourably received abroad. A more earnest movement, therefore, for the Unification of Longitude notation took place for the first time, as it became associated with the desire after uniformity in the notation of time in international relations; while it became intimately connected with our Cartographical requirements, and even penetrated into practical life. It was principally the rapid development of the means of communication through railways and telegraphs which called this desire into life; especially in America where the increased communication and the great extent of country, making the question of time one of special importance, demanded some settlement of the matter.

Before we enter upon the proceedings of the Washington Conference it will, perhaps, be of advantage at this place to signify in a few words the objects to be attained by the unification of Time notation which make that step desirable. All sciences are in common interested in the result. Navigation, the Administration of Telegraphs and Railways. Ordinary every-day life, which in its locality is regulated by the sun, would not immediately be affected by it.

In the first place, let us look at the signification of the Unification of Time with regard to science. Thus it is perfectly plain that besides astronomy those sciences are especially interested which have relation to the phenomena of the globe, namely Physics, Meteorology, and Magnetism. For the last named it is of importance that so far as possible, identity in the determination of Time should be established, according to which certain observations which have been or are to be made will be referred. It may for example be remembered that for some time past the local time of Göttingen has been used as the Normal Time for simultaneous magnetic observations, because from thence the first impulse to such observations was given through Gauss. Similar arrangements, it is true, may be made in each case in the future when there is a question of certain definite observations being set forth to the same absolute Time; but it would in like matters much shorten such operations if once for all a Normal Time were established, and it was not necessary on each particular occasion to make special arrangements on the point. It may appear paradoxical to say that of all sciences, astronomy, in despite of its vocation closely

to establish precision of time and to define motion in given periods, least of all requires such an accord. The explanation lies in the fact that astronomers, besides being accustomed to reduce to a common measure of Time, different places and the different observations made, are always in the position more easily so to reduce such observations than the representatives of other sciences, who have to deal only occasionally with Time and matters of Longitude. . It must not, however, fail to be recognized that also for astronomy, benefit would arrive if the astronomers scattered over the earth's surface would make it a law among themselves for certain observations in the matter of Time to be referred to one and the same Meridian.

Applied to navigation, as can be well understood, the question enters into practical life. But the navigator, like the astronomer, has continually to consider the principle of difference of Time, and hence a law relative to the Unification of Time notation is of less relative significance to him. Whereas in other respects uniformity in the delineation of geographical Longitudes upon sea charts, and in the register of geographical sites, would be of substantial use, as well for the safety of navigation as for convenience in calculation.

In the matter of telegraphs it would principally be their administration which would derive advantages from one Time notation for the whole world. If despatches be solely sent as desired, according to Local or to Normal Time described, so sharp control can scarcely be exercised over delays or other hindrances, without repeated inquiries to and fro. By the general application of Universal Time, difficulties in this respect would be reduced considerably. Thus also the great body of the public would be a gainer, for then everybody would be in the position to know with certainty when the despatch in question was delivered; a circumstance which may be of the greatest importance in many cases, as well in commercial relations as in many other questions of civic life.

With regard to railway-communication, it is possible to introduce Standard Time to be observed within the territory of a single country, or to groups of countries bound together by close relations, by which the administration of the lines, and the movements of trains may be regulated; while with regard to the public, the Time to be exhibited can still adhere to the Time by which every day life is regulated, be it Local or Standard Time. Such has already been the case for some time in many countries, and has undoubtedly been attended with great advantages to the interior channels of communication. Thus with us in Russia, an ordinance has been in operation for some time, by virtue of which the movements upon all railways should be governed by Pultowa Time, and on some lines, at least, it is in force. On other lines which have been constructed at a later date, this ordinance has been departed from, and in different ways the movement has been regulated by the local Time of one of the

two termini, or by the Time of some point lying intermediate. This want of conformity with us, as it appears, hitherto has not brought to light any special consequences by which injury has resulted: possibly with this exception, that occasional stoppages have arisen from the irregularity of the trains, as for instance, the transport of freight can bear witness. But that through this want of conformity of Time, the more likely danger of collisions has not more frequently happened, is indeed to be ascribed to the fact that our railway communication with other countries has only been partially developed, and the rate of speed of the trains, in spite of the greater lengths of single lines, is considerably less than elsewhere. Under these circumstances, it appears by the free use of the telegraph, collisions are avoided. But it is to be expected that with time, this constant untrustworthy expedient will not be sufficient, and that, as a consequence, owing to an increased communication, a decided and identical Time will be again made obligatory on the administration of all Russian railways.

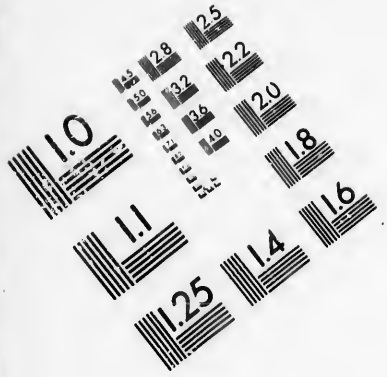
Until lately a similar condition of things existed in North America with regard to the notation of Time on Railways. There, as with us, Railway Time was not governed by a common binding law. But the administration of single lines accepted, for the movement of trains generally, the origin of Normal Time, which in the easiest manner they could obtain from one of the observatories in the neighbourhood of the line. The complications which arose from this want of conformity in the enormous increase of railway communication, furnished the starting point to the extended effort which was made last year in North America on behalf of a strict wide-spread regulation on the subject of Time Notation established by the Railway administrations, not simply within the territory of the United States but where possible over the entire continent. Had the matter alone applied to the United States it would have been easy possibly to establish the desired good understanding either through a resolution of Congress or by a convention of the directors of the several lines. But, at the same time, the desire arose to include in the same strict arrangement the railways of neighbouring states, which equally in the matter of Time Notation were subjected to local enactments and incidental changes. This desired arrangement could only be obtained by international agreement. Such an agreement obtained by means of an international conference or congress became so much the more desirable when this beneficial result, principally sought after for the new continent, could equally extend its good results to all the civilized states of the earth: and at the same time it was to be expected that resolutions passed in such a meeting would be held to be binding on each individual country with an enhanced degree of force.

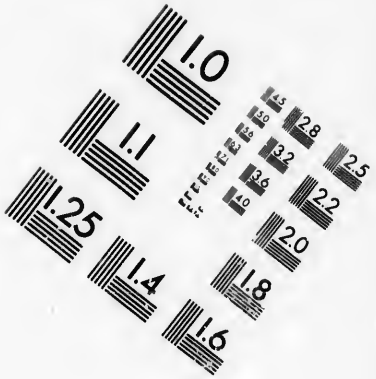
It is especially during the last ten years that those persons who in North America have taken interest in such questions have

directed their efforts towards the accomplishment of an international convention of this character which, at the same time, should form some determination with regard to the First Meridian generally to be accepted. A point which, if with regard to the immediate object of the congress is not indispensably necessary, has, from its near connection with it, become included in its consideration. Among such as these, pre-eminent mention must be made of Mr. Sandford Fleming, sometime Chief Engineer of the main lines of railway in Canada, at present Chancellor of Queen's University, Kingston. It is through his indefatigable personal efforts and writings that influential individuals and scientific and practical societies and institutes in America as in Europe have been gained to the cause. Especially the Canadian Institute in Toronto, the American Society of Civil Engineers, and the American Metrological Society of New York, who in common busied themselves with the question and appointed special commissions to consider the subject, and passed resolutions for the further prosecution of the business. The result of these efforts was that the Government of the United States of North America in August, 1882, was induced through their diplomatic representatives at the Governments of all civilized countries to invite the latter to send delegates to an international conference to be held at Washington to consider the question.

It must be regarded as an important preparation to this conference, that scientific men in Europe had had an opportunity beforehand of exchanging their views on the subject under consideration, and were enabled from their own standpoint authoritatively to recommend certain resolutions which could count upon the support of their respective Governments. The initiative was taken by the Senate of the free city of Hamburg which proposed that the subject should be brought up at the Congress, summoned to meet in Rome in September, 1883, of European Astronomers and of men interested in Geodesy and in the division of measurement of the degree. The permanent Committee of the latter Society willingly accepted the proposition, and convened for this object a meeting of prominent scientific men, who, beside the immediate matter of the measurement of the degree, issued an invitation to other learned men to take part in the deliberations, from which a satisfactory opinion with regard to the Unification of Longitude and Time could be expected.

It was seen from the beginning that with regard to the important matter, the choice of a First Meridan, a marked majority would declare itself in favour of Greenwich, which, apart from all other considerations, sufficiently satisfactorily commended itself upon the ground that approximately nine-tenths of all the Sea Charts in use on sea voyages are constructed according to this Meridian, so that the common acceptance would be effected in the easiest manner, and would call





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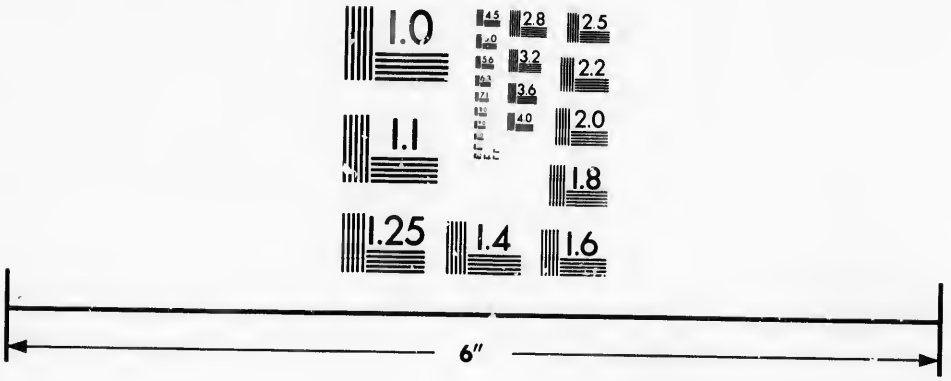

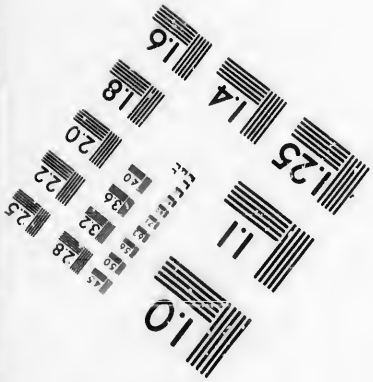

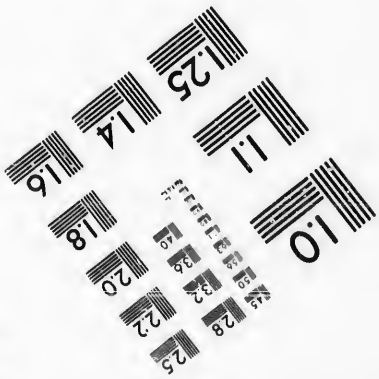

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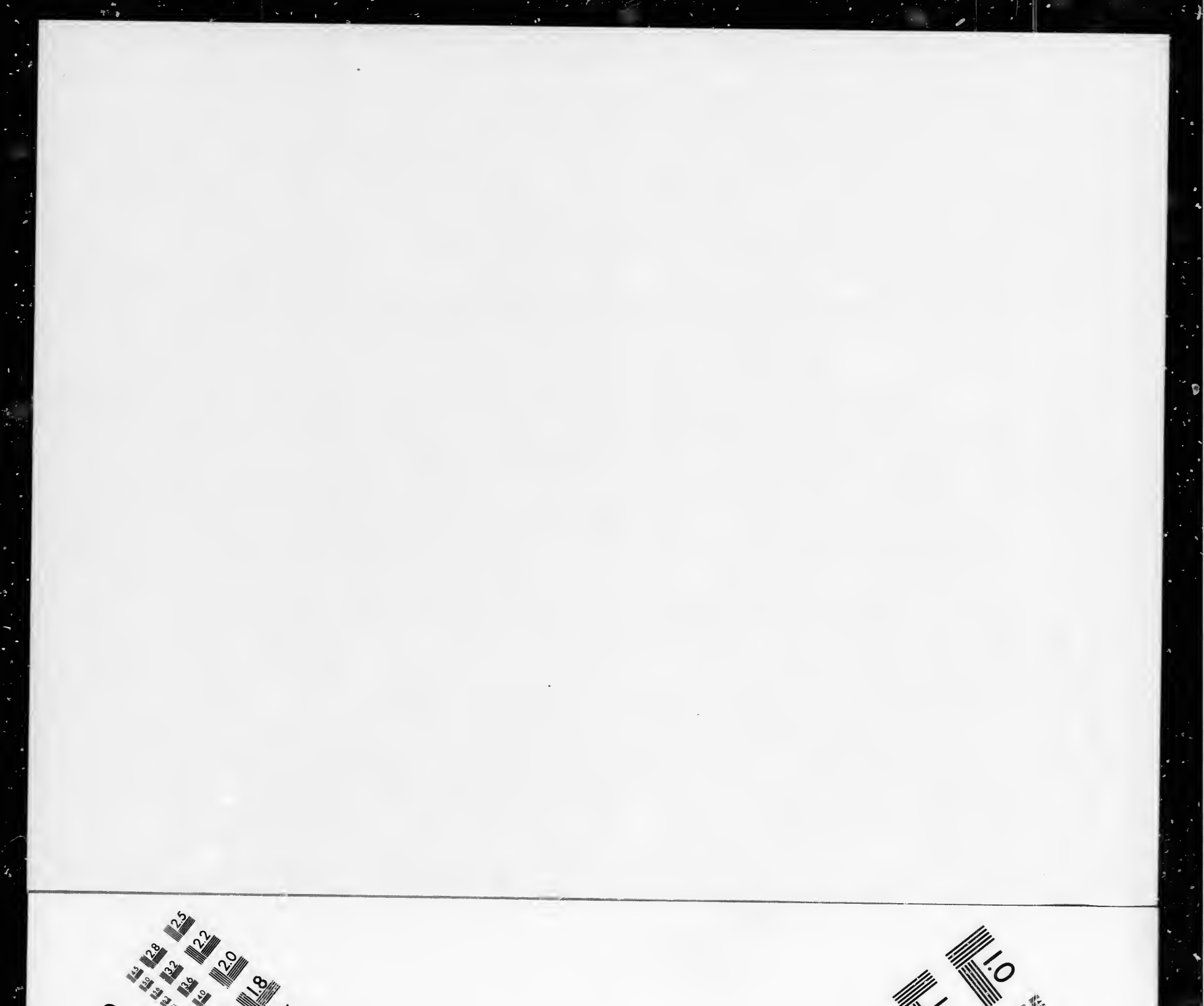


relatively for the slightest sacrifice from other countries taken collectively. In the mean time, it was by no means unknown that also other Meridians, namely, that of Paris and the Meridian distant from it 20° in round numbers, which it has been customary to describe as that of Ferro, had well-grounded claims to consideration. Astronomers claimed for the former, that of Paris, that the classic labours of Laplace, Bessel, Leverrier, Hansen and others had been based upon this Initial Meridian, which had thus been taken as their starting point on Astronomical Territory. It was urged with regard to the latter, that it was the object of constant reference in School Atlasses of Germany, Russia and other lands. On the other hand, with regard to Greenwich, besides the practical advantages already named, it could be especially claimed that by far the majority of geographical positions on the earth's surface, were principally established according to this Meridian; and that the Greenwich Observatory for more than two centuries having published continuous observations on the Moon's motion, and through manifold labours and investigations bearing on navigation, had rendered such service to geography and navigation, which no other institution could adduce, or even in any way approach.

Influenced by such considerations, it followed that at the Congress at Rome, the resolution in a certain manner was unanimously adopted to recommend for general acceptance as First Meridian that of Greenwich. Even the numerous French representatives, many of them persons of importance, did not oppose this step, but by abstaining from voting, contented themselves with this expression of sympathy, with the Meridian of Paris so acceptable to them. Likewise, some other resolutions bearing upon the subject were at the same time carried with such a large majority as almost to make the vote unanimous: viz., that the Longitudes should be numbered from Greenwich to the East around the whole earth to 360°; that the Universal Time to be introduced, should be Mean Solar Time, taken from the First Meridian, and that the notation of the latter should be without division of the day in two halves, but carried on to 24 hours. A more lively discussion was created by the question, whether the numeration of Universal Time should begin at Greenwich, mid-day or mid-night, was decided in favour of the former. During the consideration of this resolution, the fact came into strong prominence, that as the present custom of astronomers, and to some extent of navigators, is to reckon the date from noon, the arrangement of details and the difficulties which a departure from this custom would carry with it, would be felt equally by astronomical chronology, as by the calculator of the Ephemerides. In conclusion, two resolutions were accepted by the Congress of Rome, the purport of which was in no way connected with its special purpose. One of these set forth, that it was desirable for certain ends, especially for geodesy, that the decimal notation should be introduced into the circle; and the wish was

expressed by others present, that the Greenwich Meridian having been accepted as First Meridian, might be looked upon by the British Government as an equivalent, which might lead them to accede to the Metre Convention of 1875. The last result did actually take place last year.

In the meantime the Government of the United States had received replies from the greater number of other Governments, expressing their readiness to send delegates to the proposed International Conference; and after that it had been established in Rome, that unanimity in relation to the determination of a First Meridian was proportionably easy of attainment, the Government of the United States sent invitations to all civilized States to attend a Congress which should be held at Washington October 1, 1884.

In this place (Russia) as a further preparation for the Conference, on the proposal of the Geographical Society, a Special Commission was appointed, consisting of representatives of the War and Marine Departments, of the Imperial Academy of Sciences, and the Geographical Society, in order to examine into the question in connection with the main line of discussion, to signify the persons to be delegated to Washington on the part of Russia, and to submit and draw up instructions for their guidance. It may here be incidentally mentioned that with regard to these instructions, the purport of which was set forth in a short paper written by one of the Commission, Lieutenant-Colonel Rylke, that in all essential points they fully agree with the resolutions passed at Washington at a later date. The following delegates to Washington were recommended by the Commission and therefore named by the Government:—1. The Russian Ambassador to the United States, C. von Struve, who through his extended travels and his geographical labours in Central Asia, possesses at the same time special qualities for the scientific discussions which might be looked for. 2. Chief of Caucasian Survey, General Major Stebnitzki, well known through his not less comprehensive as carefully executed geodetic labours, and for the marked scientific spirit with which they have been carried out. 3. Herr Kologruvoff, member of the Council of Routes and Communications

Other countries were represented at the Washington Conference as follows:—United States, 5 delegates; Great Britain, 4; Spain, 3; Germany, France, Hawaii, Mexico and Chili, 2 each. The remaining States had one delegate. The *diplomates* accredited to the Government of the United States for the most part also assumed similar duties; for the prominent questions came before them for consideration not so much in a scientific point of view as from the standpoint of general use and international communication. But accurate science was also pre-eminently represented at the Congress. Without regard to the many experienced men prominent from their geodetic and hydrographic labours, who with right may claim to be held as efficient

representatives of the interests of science, the Congress counted in its midst as delegates the world-renowned Director of the Cambridge Observatory, Mr. Adams; the Associate of the Academy of Sciences at Paris, M. Janssen; Mr. L. M. Rutherford, of New York, of acknowledged merit by his labours in the territory of Astrophysics; the scientific representative of the U. S. Signal Office, Mr. Cleveland Abbe. Besides as it opportunely happened that many scientific men were in Washington domiciled, or accidentally there for a time, the Congress invited them to express their opinion on the matters under consideration; the head of the American Nautical Almanac, Mr. S. Newcomb, renowned by his genial and comprehensive labours in the field of astronomy; the Director of the Coast Survey, Mr. Hilgard; the celebrated natural philosopher, Sir William Thompson, and the Director of the Carlsruhe Observatory, Dr. Valentiner.

In the whole, 25 countries were represented at the conference. It was resolved that voting would be simply by states, with equal authority without regard to the number of representatives, or the stand-point of national development [*Culturstand*], the extent of territory, or the amount of population of each country. There were many important points of consideration differing in character, which pointed towards this mode of proceeding. Indeed, as it turned out, a procedure essentially different apparently would have led to the same result, as the proceedings, as they are set forth in the Protocol, testify. In all important matters, Great Britain and the United States went hand in hand with Russia, and this accord on the part of the representatives of those countries, which, at least with regard to extent of territory, were the most affected by the questions under discussion, perceptibly exercised great influence on the result of the vote.

As the conference on the 1st October, 1884, met in the Diplomatic Hall of the Department of State, in Washington, they immediately selected as President the Honourable Admiral Rogers, of the American Navy. The prudence, skill, and impartiality with which he presided over the proceedings are sufficiently established in the record of the Protocol. Lieut.-General Strachey, of the English, M. Janssen, of the French, Dr. Cruls, of the Brazilian Legation, were appointed Secretaries.

The conference held eight sittings between October 1st and November 1st; some of which were prolonged for many hours. After several delegates, among them those of Russia, had made the declaration that they were unable to consider the resolutions of the conference as binding on the countries which they represented, and that they could only pledge themselves to recommend to their respective governments, such resolutions as they might vote for, the determination was then taken as to organization, and the mode of conducting the business of the congress. With regard to the essential

business of the congress, after a debate, in some respects often animated, the following eight resolutions were passed :—

I.—That it is the opinion of this congress that it is desirable to adopt a single Prime Meridian for all nations, in place of the multiplicity of initial Meridians which now exist.—[*Unanimously adopted.*]

II.—That the conference proposes to the governments here represented the adoption of the Meridian passing through the centre of the transit instrument at the Observatory at Greenwich, as the Initial Meridian for Longitude.—[*Ayes, 22 ; noes, 1 ; abstaining, 2.*]

III.—That from this Meridian Longitude shall be counted in two directions up to 180 degrees, East Longitude being *plus* and West Longitude *minus*.—[*Ayes, 14* ; *noes, 5 ; abstaining 1.*]

IV.—That the Conference proposes the adoption of a Universal day for all purposes for which it may be found convenient, and which shall not interfere with the use of local or other Standard Time where desirable. —[*Ayes, 23 ; abstaining, 2.*]

V.—That this Universal day is to be a mean Solar day ; is to begin for all the world at the moment of mean midnight of the initial meridian, coinciding with the beginning of the civil day and date of that Meridian, and is to be counted from zero up to twenty-four hours.—[*Ayes, 15 ; noes, 2 ; abstaining, 7.*]

VI.—That the Conference expresses the hope that as soon as may be practicable the astronomical and nautical days will be arranged everywhere to begin at mean midnight.—*Carried without division.*

VII.—That the Conference expresses the hope that the technical studies designed to regulate and extend the application of the decimal system to the division of Angular Space and of Time shall be resumed so as to permit the extension of this application to all cases in which it presents real advantages.—*Ayes, 21* ; *abstaining, 3.*]

VIII.—That a copy of the Resolutions passed by this Conference shall be communicated to the Government of the United States of America, at whose instance and within whose territory the Conference has been convened.—[*Adopted unanimously.*]

The first Resolution was manifestly purely formal. It merely stated the end for which the Congress was called together, somewhat more fully than had been done in the invitation. The last resolution is also of the same character, a formal conclusion of the matters under consideration, as the results looked for will lead to further diplomatic proceeding with regard to the resolutions adopted.

We beg leave to enter here into some further discussion with regard to the other six resolutions.

During the discussion on the choice of the First Meridian the French delegates made the proposition that in place of passing through a specified observatory, the choice should, if possible, be made of an entirely neutral Meridian. Plausible as this proposition appears at the first glance to set aside all national jealousies, so the very definition of what was meant by an absolute neutral Meridian, at once hit upon serious difficulties. Moreover the proposition appeared even in a more unfavourable light upon closer

consideration of the conditions necessary to satisfy a neutral Meridian. For to be of importance as a First Meridian among others, and in order to admit of no ambiguity it must contain in itself a departure from the principle of neutrality by the determination of its position of Longitude through an observatory in the neighbourhood to be designated authoritatively.

The idea of selection on grounds of neutrality was therefore set aside by a great majority. The remark of M. Janssen, on the occasion of the discussion of this subject must be recognized as most just. Namely, that the Meridian of Ferro, introduced at the commencement of the 18th century, through De L'Isle, and subsequently brought into common use, lying 20° to the west of that of Paris, by that fact furnished a marked objection to its selection as the common First Meridian, for from this circumstance it had become purely a French Meridian, and thus, to the great disadvantage of all geography, the Meridian of Ferro had lost its international or neutral character.

After the theory of a neutral Meridian was set aside, the grounds on which Greenwich as the starting point of longitude was advocated, came into prominence with their fullest force, and the choice of it as the initial Meridian, followed almost with unanimity, France and Brazil as advocates of the neutrality principle, abstained from voting, and only the representative of San Domingo, M. de Galvan, voted positively against Greenwich. The latter, however, added that his negative vote must only be taken as an expression of his sympathy with the principle of neutrality.

The three succeeding Resolutions, the numbering of Longitudes with different signs, East and West from Greenwich; the acceptance of an Universal Day for special purposes; and the accord of this Universal Day with the Time Reckoning of civil life under the First Meridian, were in their essence internally connected one with the other. The discussion in the Conference accordingly was directed at the same time equally to the three Resolutions, although the vote upon them was given on each proposition separately. It is a matter worthy of attention, that the second, which set forth the main principle, was the only one which obtained an almost unanimous vote, while for the two others many countries abstained from voting, some of the smaller territories even voting negatively. An explanation of this manifestation is found in the fact that a great number of the Delegates were not provided with special instructions in regard to particular questions, but had only received as a rule of conduct that they should hold to the Resolutions of the Congress at Rome, which in these two particular points had decided in the opposite direction. These Delegates evidently did not feel themselves at liberty to depart from what had been laid down at Rome, even when their own personal views in the course of the discussions at Washington rather inclined them to the prevailing direction of the Resolutions there brought forward,

on the ground of common utility and their conformability to the requirements of the case.

In Rome, namely, it was proposed that the Longitudes departing from the custom observed, should be numbered around the whole earth from West to East, and this proposition was there accepted without further discussion; so that nothing definite is known concerning the reasons on which this resolution was founded. In Washington, on the other hand, this question was fully discussed. It was there expressly and forcibly urged that the resolution adopted at Rome was fraught with mischief for Cartography, that a departure from the numbering in use $\pm$ 180° from the Initial Meridian, in no way offered any scientific advantage, and that the numbering of Longitude to 360°—the 24 hours of the ultimately asked-for change of Civic Time into proposed Universal Time—from want of practice, would cause great difficulties and complications. It resulted accordingly that the maintenance of the system in use, found no special effective opposition from any side.

It was different with regard to the question whether Universal Time should commence with Greenwich, mid-day or mid-night. This question in Rome, as in Washington, was discussed in detail. At Rome the preference was given to mid-day, as thereby the interests of astronomers and navigators were especially brought into prominence. At Washington, on the other hand, the seamen who were present at the Congress maintained that the new principle was of no actual importance for men of their calling, a view which was held also by the Russian naval men.

It was also mentioned that already in the United States Marine it was a common practice as in ordinary civic life to count the commencement of the day from midnight. Consequently the argument came with greater weight in the Washington Congress that the translation of the commencement of the Universal Day to Greenwich midday would cause considerable disturbance to Trade and Commerce in the most populous territories of the world; while at these places during the most important business hours, in the period approaching midday, a double set of dates must come into use. In the presence of an argument of this character, the interests of the astronomer, which alone must suffer from the determination must naturally be placed in the background. So, as above remarked, the resolution to take midnight at Greenwich as the commencent of the Universal Day was carried by a two-thirds majority, 7 countries abstaining from voting, 2 voting negatively.

During the discussions on the Universal day an opportunity was given to Mr. Sandford Fleming to submit his generally well-known opinions as to the form in which the common acceptance of Universal Time can take the place of the ordinary time affecting civil life which in each particular place depends on the rising and setting of the sun.

These opinions have taken root in North America. For about a year, especially by the impulse given by the administrations of railways, the United States and Canada, not through force of law, but by common arrangement of those interested, have been divided into six divisions, within the boundaries of which the time notation of ordinary life, although in a strict sense answering only to the middle Longitude of the Time-division, is taken as a constant, which in the successive time-divisions each differs from the other a full hour. According to the communications of the delegate of the United States, Mr. W. F. Allen, this arrangement has been accepted by not less than 85 *per cent.* of the cities of the United States containing 10,000 inhabitants, and 80 per cent. of the administrations of railways affected. For this period no practical difficulties have been reported even in those places where the true Time of the place differs half an hour from the Division-time introduced. But that some necessary difficulties must be experienced by this arrangement in actual civic life is proved by the observation that within these Time-divisions where at the boundaries there is a clear round hour where one can differ from the other, certain every-day occupations, for example, the hours of labour of the day-labourer with regard to the same use of day light must be established in a different manner with regard to each other, according as the spot under consideration lies to the east or western boundary of the Division. How this mode of proceeding is regarded by the inhabitants of the prairie-land the report in no way informs us. It would, however, be a matter of surprise if serious complications did not arise. For instance, village communities, which are only a couple of kilometres apart [1 2-5th miles] or are yet nearer neighbours, must make use of Time notations which differ an entire hour. So it forces itself on our attention that in a community of countries of which Europe consists, in which individual states, apart from their geographical position, gravitate to one side more than the other in their commercial, industrial, or political relationship, that by the adoption of similar proceedings they would be subjected to embarrassments perfectly unsupportable. Nevertheless, the attempt made in America is full of interest and instruction, and by the favourable result which it is said the first year has effected, it becomes a matter for serious reflection that this method of Time reckoning has been fully naturalized in the United States, and perhaps will be accepted by other countries. The same principle is also applied and has also been long in use in Great Britain, of which the isolated position and scarcely an extent of 30 minutes in longitude have greatly facilitated its introduction. In any case the further extension of the principle is yet in the category of experiments, and for this reason the Washington Conference did not recognize that it was in a position to offer a resolution on the subject, or even to enter into its discussion in detail.

It might be remarked that the method adopted for the period of dating the Universal Day accepted by the Conference, would not

interfere with the system followed by astronomers. That astronomers would quietly remain in their old customs without grieving themselves as to the arrangement of a matter indifferent to them. At a period when everything tends to the simplification of reciprocal relationships, it must appear to us desirable that the numeration of date differing from the rest of the world, must also be abandoned by astronomers, and indeed for the greater reason, that in modern times the mission of many observatories is not simply to subserve scientific purposes, but also to unite with them matters of practical utility. The latter are thrown into active communication with the outer world, which, with a double notation of the date, would be much prejudiced. The sixth resolution of the Washington congress, with regard to Time Notation, unanimously voted, which expresses the hope that as soon as it appear practicable to carry out the principle, astronomers and navigators should introduce into their practice the principle of dating the day from midnight, carries this view. The Russian delegates joined in this strongly felt hope; although, in the instructions given to them, this question had not been mooted.

The seventh resolution, submitted according to the wish of Herr Janssen [recommendation, that the studies over the Decimal Division of Angles and Time should be resumed] intrinsically stands in no relationship with the propositions which were submitted to the Washington conference, and was from the first declared by the President as not coming within its powers. But a majority of those present, out of regard to the French delegates, and out of consideration for the indirect form in which the resolution was set forth, declared that it was permissible to vote upon it. Accordingly, without further discussion, it was almost unanimously accepted.

It is now asked by everybody, whether there is any prospect that the Washington Resolutions will come into operation, and by what means that result may be attained? In fact they are to be regarded principally as an authoritive expression of men enjoying public confidence in the different countries whose Governments in no way have pledged themselves unconditionally to accept the Resolutions and to give them the force of law. It, however, can be foreseen, that sustained by these important expressions of opinion, the logic of facts, and the necessity for the realization of these resolutions will possibly in no distant time lead to that result. Therefore, naturally it comes to be pre-eminently a duty for those who in the different countries are in the position to exercise influence in this direction, to make this influence felt in the sphere of their labours.

It may be considered as certain that the use of the Greenwich Meridian for Cartography and the numeration of Longitude will shortly, and without difficulties being created, be introduced into all countries. In this matter, the organs of the Governments of the three most widely extended countries, Russia, Great Britain, and the

United States of North America, have come to an understanding, and in other countries, such as Germany and Italy, the like result may be looked for, as the same Meridian is already there legally introduced in the preparation of the Hydrographic Charts. Possibly France, out of national feeling, may for some time appear as holding back. Eventually, however, it may be looked for, that regard for the common good, and for the actual interests of its own navigation, may cause the Government of that country to make the unification complete. We may, therefore, regard the chief object of the Washington Conference, namely, the establishment of the First Meridian, from which all the remaining questions are more or less natural consequences, as satisfactorily solved.

Possibly the introduction of Universal Time may experience greater difficulties in the administration of commercial institutions, as this innovation will act upon a numerous class of people, and awaken new ideas on questions with which they have had little occasion to make themselves familiar. In the meantime, according to the opinion of men capable of appreciating these difficulties, at least in Russia, where there is great extent in Longitude, besides where the ideas over the differences of Time Notation are more complicated than elsewhere, they are less important than at the first glance they would appear to be. It is to be expected that at the present time the constantly repeated Congresses on Railway, Post and Telegraph Administration will soon occupy themselves with this matter, and sustained by the authority of the Washington Congress, will call into practice the Resolutions in this respect which were passed there.

Much earnest reflection, on the other hand, must be given to the desire expressed at the meeting, that Astronomical Time Reckoning should be brought in accord with the commencement of the day in civil life.

In this matter astronomers have not simply to abandon a custom of long standing, and consequently to make conditional changes of practice established for many years, but at the same time astronomical chronology is disturbed, which it is easily understood, must exercise a marked effect on the comprehension of all problems bearing upon motion. Without doubt, the astronomer must make a great sacrifice for the fulfilment of this desire; but in reality this sacrifice is not greater than that entailed on our forefathers, when they passed from the Julian to the Gregorian Notation of Time, or when they altered the commencement of the year: a sacrifice of convenience, by which we yet suffer when it becomes necessary to refer to phenomena of remote dates. At this period we must the less stand in fear of a like sacrifice, when by such means an acknowledged existing non-accord between science and ordinary life can be set aside: a non-accord which it is true in individual cases does not press heavily on the astronomer, but which is a constant source of inconvenience for non-professional

astronomers, who are desirous of making use of astronomical information. And in such respect this sacrifice ceases so to be considered and is transformed into an act of public utility with regard to all astronomical details which stand in clear relationship with the outer world, in which almost daily conflicts come to the surface between the different designations of dates. Conflicts, among others, which even are injurious to astronomical labours in such observatories, where observations are continually adjusted to the day.

Great Britain, apparently, has the greatest reason to be satisfied with the Washington Resolutions, for, in her case, there is the greatest accomplishment of her wishes, with a minimum of discomfort and sacrifice. The cartography of the whole Kingdom and its Colonies is already based on the Meridian of Greenwich, and the notation of time in commercial relations in civil life in England and Scotland is determined by mean Greenwich Time, which hereafter also will be recognized as Universal Time. This preference is a tribute of gratitude for the immense expenditure of time and labour which for more than two centuries English astronomers, navigators and geographers have continuously bestowed on geography and navigation, far exceeding all that in this respect has been done by all other countries. But, on the other hand, this preference has imposed upon England the moral obligation to exert herself to carry out earnestly the wishes expressed at the Washington Conference, namely, the establishment of accord between ordinary Astronomical and Nautical Time notation. It is deserving of comment that this obligation is recognized and that the present Astronomer Royal, Mr. H. M. Christie, already has taken the first step in this direction. Since the 1st of January of this year, the date of observations, and chiefly in the interior economy of the Greenwich Observatory, the date will be set forth equally for the mean Greenwich Time hitherto used and also for Universal Time. In all the publications issued from this Observatory the old mode of notation will be maintained until it appear advisable to use exclusively Universal Time. At the same time Mr. Christie has given instructions that the great dial which stands at the entrance to Greenwich Observatory, which in a manner regulates the time for the whole of England, being continually brought into requisition by the public, henceforth will show Universal Time from midnight to the 24 succeeding hours. It must appear not less important that the directors of the Nautical Almanac have in deliberation whether and when the corresponding changes in its arrangement with regard to all other disseminated Ephemerides are to commence in order to make them accord with the Date-notation of Universal Time. Possibly it might be arranged to come to pass for the year 1890.

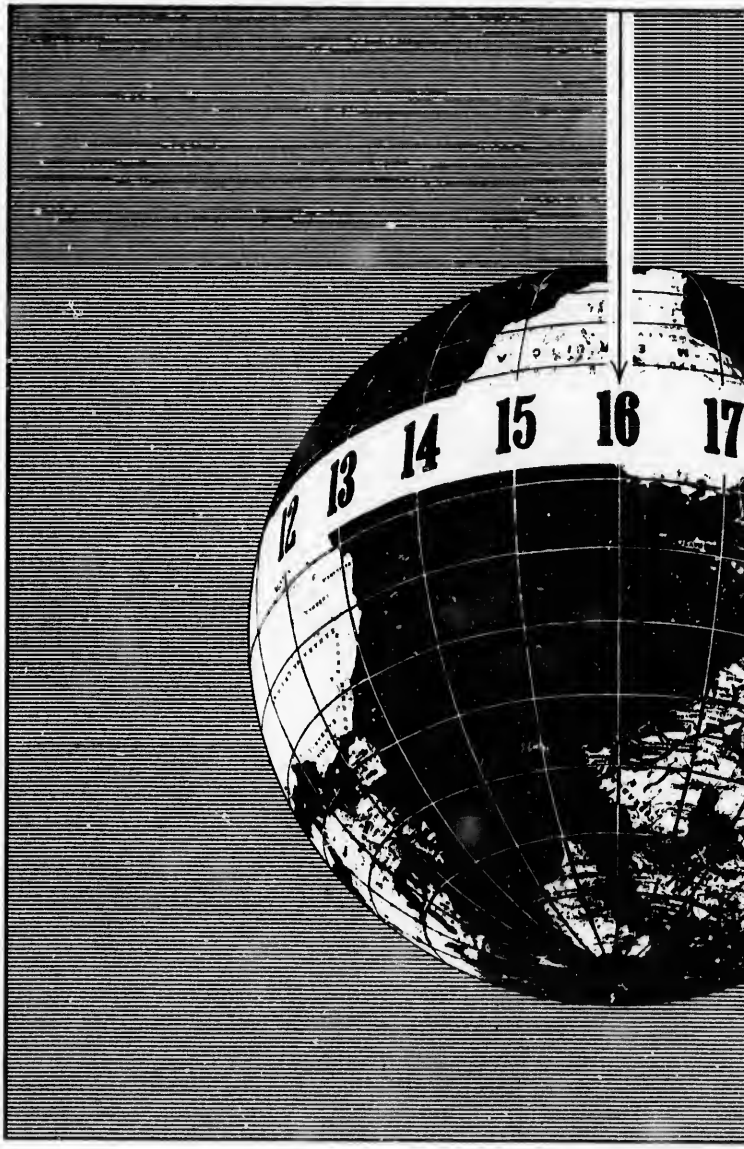
While the Directors of the Pultowa Observatory make their full acknowledgment to the Astronomer Royal for this precedent which

has been established, so are they ready to follow the example; and this fact leads us the more to expect that also this course will be adopted by the Washington Naval Observatory, as in the American Marine the Date-notation from midnight has been already accepted. It is only in the matter of the period, when the Date-notation, according to Universal Time, should be introduced into the publications of the observatories, that we feel inclined to recommend, that there should be delay until in this respect the most perfect possible understanding be attained by all astronomers, in order to avoid the much more critical disturbance in astronomical chronology which would arise, if the transition to the new Date-notation was not equally followed on all sides. We are desirous, accordingly, of suggesting a suitable time-point for the commencement of the year, for which the Nautical Almanac would inaugurate the changes corresponding to the requirements named. The latter has before been said could come to pass in the year 1890. We would, however, ourselves prefer the change to take place, in the first instance, with the change of the century. Until that date, it would probably be the simultaneous proceeding of all astronomers, with general consent to look forward to this period of transition, and it would more easily stamp itself on the memory of all who hereafter would be busied in investigations, in which exact chronology plays a part.

In conclusion, a circumstance may be mentioned which will be of interest to a wider circle of the public. In the Washington Conference it is true every resolution was avoided which could directly be considered as an influence on ordinary Time reckoning. But nevertheless an opportunity was offered to the Russian delegates to submit the principle and to recommend it for consideration that it certainly was desirable to introduce into ordinary Time-notation, as it is it would be also acceptable for Universal Time, to set aside the exceedingly embarrassing division of the day in two halves of 12 similarly-named hours, and in their place again introduce a continuous notation to 24 as has for some time already taken place in different countries. This idea has visibly fallen on ground well prepared to receive it, and already there is every prospect that the fruit will ripen. The instructions of the Astronomer Royal, which bear close relations to Universal Time, through the exhibition of the great clock of Greenwich Observatory divided into 24 hours in order to accustom the public of that country to the continuous hour notation for the entire day, has been greeted in the intelligent circles of England as it appears with enthusiasm as the simpler means of avoiding the so frequent matter of uncertainty whether forenoon or afternoon be meant. It is, perhaps, not quite easy to explain with any correctness, from what date and upon what grounds the present division of the day at noon into two equal parts is followed: especially as the ancient practice (for example with the Hebrews in antiquity) teaches us that the numbering the hours in one series practically offers no difficulty. At all events a

division of the day into day and night by Nature is grounded on an equal duration of the hour, as it continued with the Romans. But the division of the same into equal parts by the passage of the sun through the line of mid-day is sustained by no natural principle which can stand the test of proof. The very name mid-day testifies not to the division of the same into two parts, but only the middle of an uninterrupted whole. It appears to us not entirely improbable that the division of the day into two parts of the like number, specification and duration of hours, has especially found a point of support in the theory that in the infancy of the art of clock-making, the technical means were wanting to the clock-maker to show upon the dial-plate sufficiently and satisfactorily divided one from the other, all the 24 different hours; especially with watches. This supposition is strengthened by the circumstance that in some countries, namely in Italy and Bohemia, even to the latest times, clocks on the tower, of which the larger size permitted all the 24 hours to be shown on their dial plate, had them so marked and with works adapted to the movement. In the present condition of the art the cause for shortening the notation of the hours has entirely passed away, and at the same time the possibility presents itself of getting rid of the inconvenience which was called forth by it. If this end be attained in coming time, the Washington Conference from the impulse which it has so far given to it, has rendered a great service to all mankind.

The Earth itself becomes the Standard Chr
The Solar passage is everywhere the Index



the Standard Chronometer for all Nations.
rywhere the Index of Cosmic Time. (see page 20.)